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EFFECTS OF NASAL INHALERS ON ERECTILE TISSUES OF THE NOSE

QUANTITATIVE STUDIES

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The introduction of the nasal inhaler into the field of rhinologic therapy has met with widespread acceptance by both the physician and the public. The nasal inhaler offers a simple and inexpensive method of obtaining symptomatic relief from the nasal congestion that accompanies rhinitis. It has the advantages of simplicity of use, compactness and efficiency of response.

Many types of inhalers are now commercially available. Some contain powerful vasoconstrictor drugs, such as amphetamine, while others contain classic rhinologic remedies, such as menthol, camphor and oil of eucalyptus.

Peters and Faulkner [1] studied the effects of volatile amphetamine on the pulse, the blood pressure and the electrocardiogram of human subjects with various pathologic conditions. They used doses larger than the therapeutic amounts employed in rhinologic practice. They concluded that the drug produced no significant changes in the pulse or the blood pressure and only slight alterations in the electrocardiogram. They warned, however, that inhalation of amphetamine may precipitate anginal pain in patients with angina pectoris.

Bertolet [2] studied a series of 122 patients with various nasal conditions, using glass amphetamine inhalers and a dose of 0.0002 Gm. of the drug. He collected subjective responses to the drug from the patients and concluded that a large majority of the patients obtained considerable relief from the use of the inhalers. He reported one reaction in a patient suffering from allergic vasomotor rhinitis. The blood pressure and the pulse were normal five and ten minutes respectively after inhalation of 0.0002 Gm. of the drug.

Sternstein [3] published the results of a study of amphetamine inhalers as the present studies reached completion. He reported measurable vasoconstriction for 270 minutes in the nonobstructed nose and for 85 to 180 minutes in cases of nasal obstruction due to various pathologic causes.

METHODS

Measurement of Nasal Obstruction.—The degree of nasal obstruction before and after administration of various drugs was measured by a method modified from that of Sternstein and Schur [4] (fig. 1). The instrument used consists of an electric suction pump attached to

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This study was aided by a grant from the Clara A. Abbott Fund of Northwestern University.

1. Peters, C. M., and Faulkner, J. M.: Circulatory Effects of Volatile Amphetamine (Benzedrine Inhaler), Am. J. M. Sc. **198**:104 (July) 1939.
2. Bertolet, J. A.: Benzyl Methyl Carbinamine Carbonate, M. J. & Rec. **136**:75 (July) 1932.
3. Sternstein, H. J.: Efficacy of Vasoconstrictor Agents in the Obstructed Nose: A Quantitative Evaluation, Arch. Otolaryng. **36**:713 (Nov.) 1942.
4. Sternstein, H. J., and Schur, M. O.: Quantitative Study of Nasal Obstruction: A New Method, Arch. Otolaryng. **23**:475 (April) 1936.

a gas flow meter and an inclined draft gage. The suction tube is attached to a nasal olive tip. A constant amount of suction is maintained by the pump and is adjusted until the flow of air is 7.3 liters per minute as measured by the flow meter. Any resistance placed over the nasal tip, such as that offered by an obstructed nose, is indicated by a fall in the level of the draft gage. Thus, any change in the degree of nasal obstruction will be indicated by a change in the draft gage reading. A flow of 7.3 liters per minute was used, since this is less than the average flow of air during normal quiet respiration and since a greater flow causes drying and irritation of the nasal mucosa, which tend to alter nasal congestion.

The subjects were trained to sit in front of a mirror and to insert the nasal tip into one nostril, closing the mouth tightly and holding the breath until a reading was made. The path of the air flow was in through one nostril, through the nasal passages of that side, through the nasopharynx into the posterior choana of the opposite nostril and thence through the nasal passages of that side and into the nasal tip (fig. 1). Thus, any change in the draft gage reading is evidence of a change in the resistance to air flow of the nasal passages or of the nasopharynx.

Two readings were taken with the nasal tip in one nostril and then two with the nasal tip in the opposite nostril. The four readings were averaged, and the average was recorded as the relative value for the nasal resistance to air flow.

It has been found by repeated trials that consistent readings can be obtained by this method, with little or no variation in reading due to the position of the tongue, glottis or palate. Such

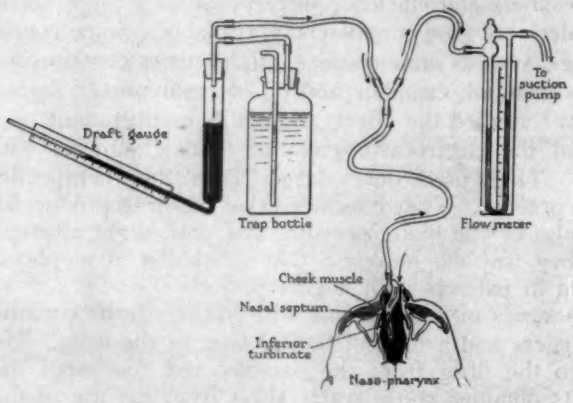

Fig. 1.—Diagram of apparatus for measuring nasal resistance to air (method modified from Sternstein and Schur [4]).

a procedure, also, has the advantage of measuring resistance of only the nasal passages. Sternstein and Schur expressed preference for the use of the nasal tip in one nostril with the mouth open and the opposite nostril closed, so that the flow of air is in through the mouth and oropharynx and thence into the nasopharynx and through the nasal passage of one side. The mouth being open, the resistance of the mouth and oropharynx are also factors in the final reading, and variations in the position of the tongue, palate and lower jaw make considerable differences in the readings.

In every experiment the nasal resistance of each subject was measured before any drug was administered. Then the subject took four deep inhalations, two inhalations into each nostril, from an inhaler of standard size and shape containing the drug being studied.[5] Nasal resistance was measured at carefully timed intervals after administration of the drug. Thus, a reading was taken at one, five, fifteen and thirty minute intervals and every thirty minutes thereafter until the nasal resistance again approached or returned to normal.

Care was taken to prevent the subject from inhaling extraneous vapors that might cause irritation and vasodilatation, such as tobacco smoke or ammonia fumes. Also, the temperature and humidity were measured and maintained as nearly constant as possible.

Normal young males were the subjects of these experiments. The same subjects were used throughout.

Attempts to use subjects with varied nasal disorders are beset with technical difficulties. Patients with acute rhinitis are not satisfactory because the inflammatory condition varies from

5. The drugs used in these experiments, with the exception of commercial products, were furnished by Dr. D. L. Tabern, of the Abbott Laboratories, North Chicago, Ill.

day to day, or even from hour to hour, and comparable experiments on two successive days would be impossible. Patients with allergic vasomotor rhinitis prove unsatisfactory because the nasal obstruction varies greatly from minute to minute, the degree depending on the amount of wind, the amount of extraneous irritant odors, etc. The highly sensitive inflamed mucosa is responsive to minute stimuli, and it is impossible to maintain constant conditions for the several hours that are needed for this type of study. Persons with chronic hypertrophic rhinitis are not satisfactory, as there is fibrosis of the mucosal membrane with permanent pathologic changes which cannot be altered by any vasoconstrictor, and conclusions reached on the basis of observations on such subjects would have little, or no, value in deducing the effects in the more common forms of rhinitis.

An interval of at least forty-eight hours elapsed between each experiment, so that the after-effects of the drug had entirely disappeared.

Measurement of the Drug Outputs of the Nasal Inhalers.—The amounts of the drugs administered on inhalation were measured by the method of Tabern.[6] The method consists of the suction of a constant amount of air through an inhaler at a constant rate, so that the "inhaled" vapors pass into a closed flask containing a known amount of standard acid. The drug, which is an organic amine, neutralizes some of the acid, and the amount can be determined by back titration with standard base. From these data the amount of drug administered can be calculated in terms of milligrams. The apparatus used in these determinations is rather complex and will be described elsewhere by Dr. Tabern.

Measurements were made only for the vasoconstrictor amines studied, and not for the perfumes or the aromatic oils. The outputs of the inhalers were checked periodically, and constant outputs were maintained throughout the experiments.

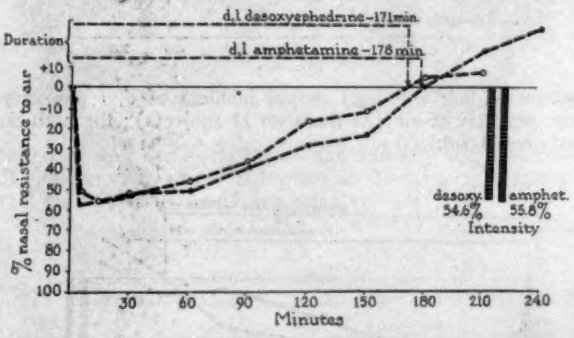

Fig. 2.—Comparison of effects of *d, l* desoxyephedrine and *d, l* amphetamine. The dose of *d, l* desoxyephedrine was 0.931 mg. per liter of air (34 trials on 11 subjects); the dose of *d, l* amphetamine, 0.776 mg. per liter of air (32 trials on 11 subjects).

RESULTS

The results of 266 experiments on 11 normal subjects are summarized in the accompanying graphs. The readings of nasal resistance for each individual experiment were computed as percentages of the normal, or basal, reading before administration of the drug. The percentage results for all experiments with the same drug were averaged, and the final average response to the drug is presented in the graph.

Zero on the graphs represents the basal nasal resistance, and any fall below that level is indicative of a decrease in nasal resistance, or a relative clearing of nasal obstruction. Any rise in reading above the base line represents an increase in nasal congestion.

Comparable Effects of d, l Desoxyephedrine and d, l Amphetamine.—This study, comprising 62 experiments on 11 subjects, revealed similar responses to the two drugs (fig. 2). Maximal nasal clearing with *d, l* desoxyephedrine was 54.6

6. Tabern, D. L.: Personal communication to the authors.

per cent of basal resistance, and that with *d, l* amphetamine was 55.8 per cent. The *d, l* amphetamine remained effective as a vasoconstrictor seven minutes longer than the *d, l* desoxyephedrine. These small differences are well within the realms of experimental error and are probably not significant.

Comparable Effects of d, l Desoxyephedrine Inhalers of Low and High Output.—This study consisted of 62 experiments on 11 subjects (fig. 3). The maximal vasoconstrictor effects were almost equal for the two inhalers. The high output inhaler was 1 per cent more effective. However, the period of action of the inhaler with the higher output of the drug was 33 minutes shorter than that of the inhaler

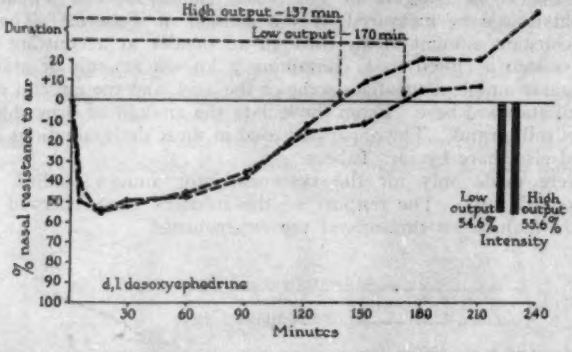

Fig. 3.—Comparison of low and high output inhalers of *d, l* desoxyephedrine. The low output was 0.931 mg. per liter of air (34 trials on 11 subjects); the high output, 1.028 mg. per liter of air (28 trials on 11 subjects).

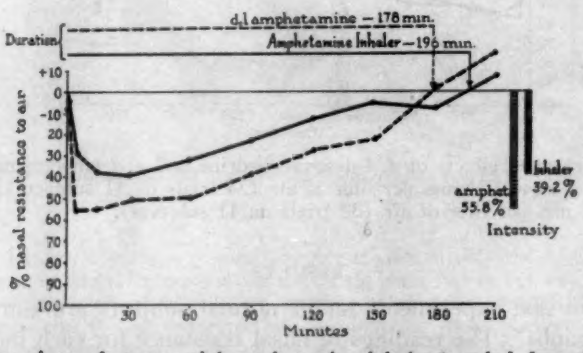

Fig. 4.—Comparison of commercial amphetamine inhaler[7] and *d, l* amphetamine. The dose of commercial amphetamine inhalant was 0.675 mg. per liter of air (51 trials on 11 subjects); the dose of *d, l* amphetamine, 0.776 mg. per liter of air (32 trials on 11 subjects).

with the lower output. The explanation of this phenomenon will be discussed later.

Comparable Effects of Commercial Amphetamine Inhaler[7] and d, l Amphetamine.—The commercial amphetamine inhaler contains *d, l* amphetamine, oil of lavender and menthol. The study, which consisted of 83 experiments on 11 subjects, indicated that the pure amphetamine was much more effective in relieving nasal obstruction than the commercial preparation (fig. 4). The pure amphetamine caused a fall in nasal resistance of 55.8 per cent, while the commercial formula

7. The commercial amphetamine inhaler used is manufactured by Smith, Kline & French Laboratories, Fifth and Arch Sts., Philadelphia, and is marketed under the name "benzedrine inhaler."

caused a fall of 39.2 per cent. The duration of response with the commercial inhaler was 18 minutes longer than that in the pure amphetamine.

Comparable Effects of d, l Desoxyephedrine and Formula 609.—Formula 609 contains *d, l* desoxyephedrine, synthetic menthol, astrotone [8] and a synthetic perfume known as N.W.C.[9] A series of 88 experiments on 11 subjects revealed that the formula was strikingly less effective than the pure drug (fig. 5).

Formula 609 had a maximum effectiveness of 29.5 per cent and *d, l* desoxyephedrine a maximum effectiveness of 54.6 per cent. Formula 609 was effective for 127 minutes, while *d, l* desoxyephedrine was effective for 171 minutes, a difference of 44 minutes.

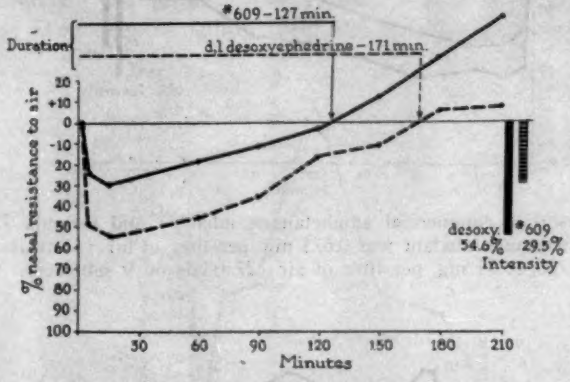

Fig. 5.—Comparison of *d, l* desoxyephedrine and formula 609. The dose of *d, l* desoxyephedrine was 0.931 mg. per liter of air (34 trials on 11 subjects); the dose of formula 609, 0.745 mg. per liter of air (54 trials on 11 subjects).

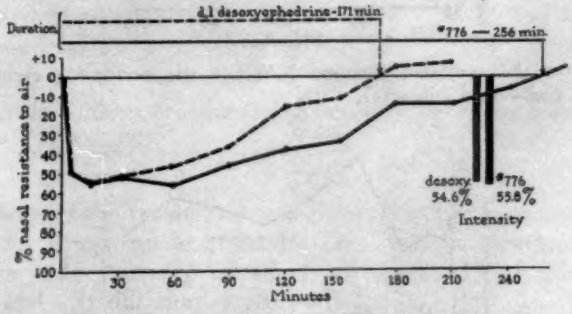

Fig. 6.—Comparison of *d, l* desoxyephedrine and formula 776. The dose of *d, l* desoxyephedrine was 0.931 mg. per liter of air (34 trials on 11 subjects); the dose of formula 776, 0.671 mg. per liter of air (27 trials on 9 subjects).

Comparable Effects of d, l Desoxyephedrine and Formula 776.—Formula 776 contains *d, l* desoxyephedrine, astrotone, the perfume N.W.C. and natural menthol. The menthol is present in approximately half the concentration of the synthetic menthol in formula 609.

A series of 61 experiments were conducted on 11 subjects (fig. 6). The maximal effects of the two inhalers were almost identical, formula 776 being 1.2 per

8. Astrotone, a perfume fixative, is manufactured by E. I. duPont de Nemours & Co., Inc., Aromatic Section, 40 Worth St., New York.

9. The synthetic perfume N.W.C. is manufactured by Fulton Chemical Co., Inc., 599 Johnson Ave., Brooklyn.

cent more effective. This difference lies within the experimental error and is probably not significant. The two inhalers showed a striking difference in the duration of effect. Formula 776 was effective for 256 minutes and the pure drug for 171 minutes. The possible causes of this difference will be discussed later.

Comparable Effects of Commercial Amphetamine Inhaler [7] *and Formula 776.*—A series of 78 experiments on 11 subjects showed some differences of interest

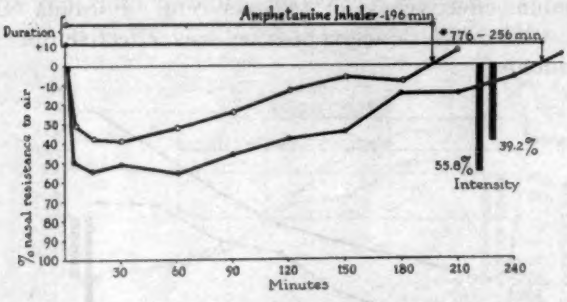

Fig. 7.—Comparison of commercial amphetamine inhaler [7] and formula 776. The dose of the commercial amphetamine inhalant was 0.675 mg. per liter of air (51 trials on 11 subjects); the dose of formula 776, 0.671 mg. per liter of air (27 trials on 9 subjects).

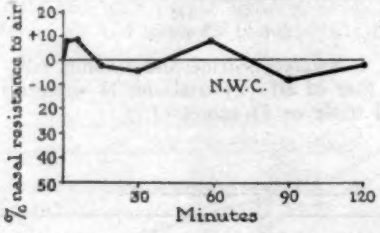

Fig. 8.—Effects of the synthetic perfume N.W.C.,[9] the perfume present in formula 609 and formula 776 (8 trials on 8 subjects).

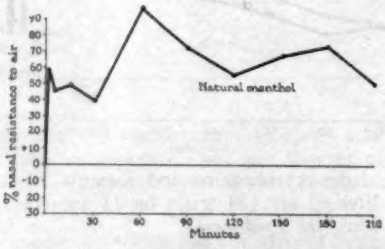

Fig. 9.—Effects of natural menthol, in the same concentration as that of the drug in formula 609 (22 trials; 9 subjects).

(fig. 7). The commercial amphetamine inhaler was 16.6 per cent less effective than formula 776 in reducing nasal congestion from the basal level. Formula 776 was effective for 60 minutes longer than the commercial inhaler.

Effects of Synthetic Perfume N.W.C.[9]—A series of 8 experiments on 8 subjects revealed no striking changes in the nasal resistance over a period of 120 minutes (fig. 8). The fluctuation of the nasal resistance was ± 9 per cent of the normal, or basal, resistance.

Effects of Natural Menthol.—Inhalation of natural menthol produced a marked increase in nasal resistance, according to the results of 22 experiments on 9 subjects (fig. 9). The nasal resistance rose rapidly within one minute after administration of the drug and remained very high even after 210 minutes. It is significant to note that subjectively the subjects did not feel congestion, but that their nasal passages felt clear.

Effects of Menthol Type Inhaler.[9a]—The effects of an inhaler containing menthol, camphor, methyl salicylate, oil of pine needles and oil of sassafras were studied in a series of 10 experiments on 9 subjects (fig. 10).

The nasal congestion resulting from this inhalant was far greater than that due to any other inhalant yet tested. The resistance rose as high as 212.9 per cent above the basal level. Again, subjectively, the nasal passages felt clear and "cool."

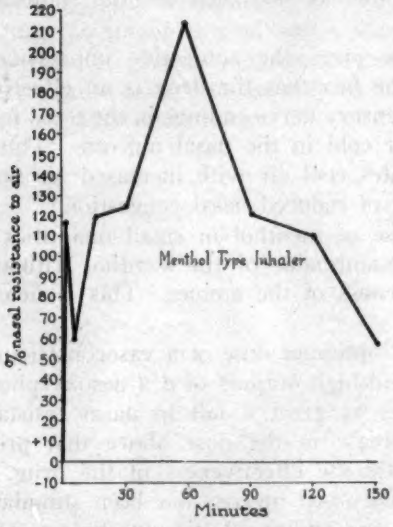

Fig. 10.—Effects of menthol type inhaler[9a] (10 trials; 9 subjects).

COMMENT

In the analysis of the results of these 266 experiments, several characteristics of the effects of the drugs can be studied. Thus, one can determine (1) latency of onset of action, (2) intensity of effect, (3) duration of effect, (4) intensity of after-effect and (5) duration of after-effect.

In the present experiments it seemed advisable to confine our conclusions to the first three of these characteristics of drug action. The after-effects of vasoconstrictor drugs occur only after many hours, and it is impossible to keep conditions controlled for more than three or four hours. Also, many individual variations have been noted in the intensity and duration of the after-congestion following the use of vasoconstrictors. These individual variations are probably due to such uncontrollable factors as faulty control of atmospheric conditions, exhaustion of the subjects and tone of individual vasomotor reflex activity at that particular time.

It will be noted from all of the graphs for vasoconstrictors that maximum relief of obstruction occurred within fifteen minutes after administration. This latency

9a. There are various menthol type inhalers. The one used in these experiments is manufactured by Vicks Chemical Company and is marketed under the name "Vicks Inhaler."

of maximum effectiveness seems the same for all formulas studied. This can probably be explained by the fact that a certain time lag is required for the drugs to penetrate the mucous blanket of the nasal mucosa and reach the vascular bed and a second time lag occurs before the musculature of the blood vessels contracts completely.

The undesirable effects of menthol are strikingly shown by the studies on pure menthol. It has been reported by Fox [10] that menthol in solutions caused nasal obstruction. The present studies broadened his conclusions to include inhaler vapors as well.

The antagonism of the vasodilator menthol and the vasoconstrictor amines explains the greater effectiveness of the pure amines over the commercial inhalers containing fairly large amounts of menthol. In some perfumed inhalers (commercial amphetamine inhaler and formula 609) much of the vasoconstrictor effectiveness of the amines is sacrificed for the subjective pleasantness derived from menthol.

Menthol used alone gives the subjective impression of reduction in nasal obstruction owing to the fact that the drug is an effective topical anesthetic and paralyzes many of the sensory nerve endings in the nasal mucosa. It also stimulates the sensory endings for cold in the nasal mucosa. Thus, inhaled air feels cool, and the subject associates cool air with increased air flow through a clear nose and has the impression of reduced nasal congestion.

By the judicious use of menthol in small quantities it has been possible to retain some of the pleasant odor of the menthol without sacrificing any of the vasoconstrictor effectiveness of the amines. This is demonstrated in the studies on formula 776.

The question of the optimum dose of a vasoconstrictor amine was the subject of the studies on low and high outputs of *d, l* desoxyephedrine inhalers. The low output inhaler produces as great a fall in nasal resistance as the high output inhaler. Thus, an increase in the dose above that present in the low output inhaler does not increase the effectiveness of the drug. Probably the vasoconstrictor mechanism of the nasal mucosa has been stimulated to maximal response by the lower dose, and any additional stimulus fails to produce any further vasoconstriction. Whether a still lower output is desirable remains for future studies to determine.

The shorter duration of effect of the higher output inhaler is also indicative of the undesirability of use of such an inhaler. It seems that the additional drug present merely has additional irritant effects, so that once the vasoconstrictor action is gone the irritation from the higher dose is greater than that from the lower dose and nasal resistance returns to the control level more rapidly.

The pronounced congestion following use of the menthol type inhaler was much greater than that due to menthol alone. This is probably due to the presence of several other aromatic ingredients in such an inhaler, which also act as nasal irritants.

The studies on formula 776 indicate a greater duration of effect with this formula than with the pure drug alone. The explanation of this fact is not obvious. It is of interest to note that the drug output of the formula 776 cartridge is definitely lower than that of the pure drug cartridge. This difference in output is due to the fixing properties of the astrotone, menthol and perfume. The prolonged effect of formula 776 may be due to either of two factors: (1) The lower output of

10. Fox, N.: Effect of Camphor, Eucalyptol and Menthol on the Vascular State of the Mucous Membrane, Arch. Otolaryng. 6:112 (Aug.) 1927.

the drug, with resultant decrease in the irritation of the vapor on the mucosa. This possibility is suggested by the longer effect of the low output of pure drug than that of the higher output of pure drug. Also, the longer action of the commercial amphetamine inhaler than that of the pure amphetamine points to the output as the factor producing longer action. (2) The fixing properties of the astrotone, menthol and perfume, releasing the drug more slowly on the mucosal blanket, so that the vasoconstrictor stimulus is prolonged by negative catalysis.

All of the present studies have been conducted on normal subjects, with no inflammation or irritation of the nasal mucosa. Whether the conclusions from such a study are applicable to persons with various pathologic conditions of the nasal mucosa is problematic and can be answered only by additional experimentation with pathologic conditions.

CONCLUSIONS

Studies of the changes in nasal resistance following the administration of various drugs reveal certain points of clinical importance concerned with these drugs. Quantitative experiments give a comparative basis for analysis of the rationale of rhinologic therapeutics and point the way to improvements in methods of administration of drugs for nasal medication.

OSTEOMA OF THE FRONTAL SINUS

REPORT OF A CASE

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The term osteoma is applied to tumors composed of bone and should be limited to true neoplasms. The tumors thus designated may be of 2 types: an ivory-like structure and a soft cancellous one, the former being the more common. True osteoma must be differentiated from the exostosis, the enostosis and the hyperostosis, and the criteria by which this can best be done are found in clinical features.

INCIDENCE

Osteoma of an accessory sinus of the nose is uncommon in my experience (limited to a single case). Many authors have stated that it is relatively common; no one of them, however, has reported a large series of cases.

Osteoma of the frontal sinus occurs most frequently. Arnold [1] in 1873 reported 2 cases and described his surgical treatment. In 1938 Malan [2] collected 458 cases of osteoma of the accessory sinuses of the nose; the involved areas were the frontal sinus in 178, the ethmoid sinus in 110, the maxillary sinus in 41 and the sphenoid sinus in 4. Knapp [3] reported 8 cases from a review of 56,000 records. Fetissof [4] cited 35 cases of osteoma of the accessory sinuses reported since 1922, in 16 of which the frontal sinus was involved. In the past twenty-five years roentgenologic study has added materially to the number of cases diagnosed and has also given valuable information as to the extent of the lesion. In about 80 per cent of the cases the tumor occurs before the age of 50. Carmody [5] reported 6 cases of osteoma of the frontal sinus occurring at ages from 11 to 42 years. Men and women seem to be involved equally, although some authors believe that osteoma of this sinus occurs more often in men.

Harris [6] in 1927 reported 2 cases of his own and summarized 28 cases from the literature between 1907 and 1927.

ETIOLOGY

Many causes have been postulated, such as trauma, sinus infections, ossification of polypi, proliferating osteitis and stimulation of embryologic rests; the older writers named syphilis as a main factor.

Arnold [1] expressed the belief that osteoma of the frontal sinus arises from an embryonic cartilaginous rest at the junction of the ethmoid and frontal bones.

This paper was presented before the Western Section of the American Laryngological, Rhinological and Otological Society at Portland, Oregon, Jan. 31, 1943.

1. Cited by Harris.[6]

2. Malan, cited by Salvadori, G.: Osteoma of the Frontal Sinus, Arch. Otolaryng. **35**: 671 (April) 1942.

3. Knapp, cited by Carmody.[5]

4. Fetissof, A. G.: The Pathogenesis of Osteomas of Nasal Accessory Sinuses, Ann. Otol., Rhin. & Laryng. **38**:404, 1929.

5. Carmody, T. E.: Osteoma of the Nasal Accessory Sinuses, Ann. Otol., Rhin. & Laryng. **44**:626, 1935.

6. Harris, R.: Osteoma of Frontal Sinus: Report of Two Cases, Laryngoscope **38**:331, 1928.

Virchow's theory was that it developed from a cartilaginous anlage which had been stimulated to bone-producing activity. Cushing in 1927 reported 4 cases of osteoma of the frontal sinus in which the beginning appeared to be at the junction of the orbital plate of the frontal bone with the edge of the ethmoid bone.

In the case reported here there was no evidence of sinus infection and no history of trauma, and the Wassermann test was negative. The point of attachment was not in the classic place mentioned by Cushing [7] but at the extreme upper and anterior wall of the frontal sinus (fig. 1 *A*). In this case, then, it seems that the

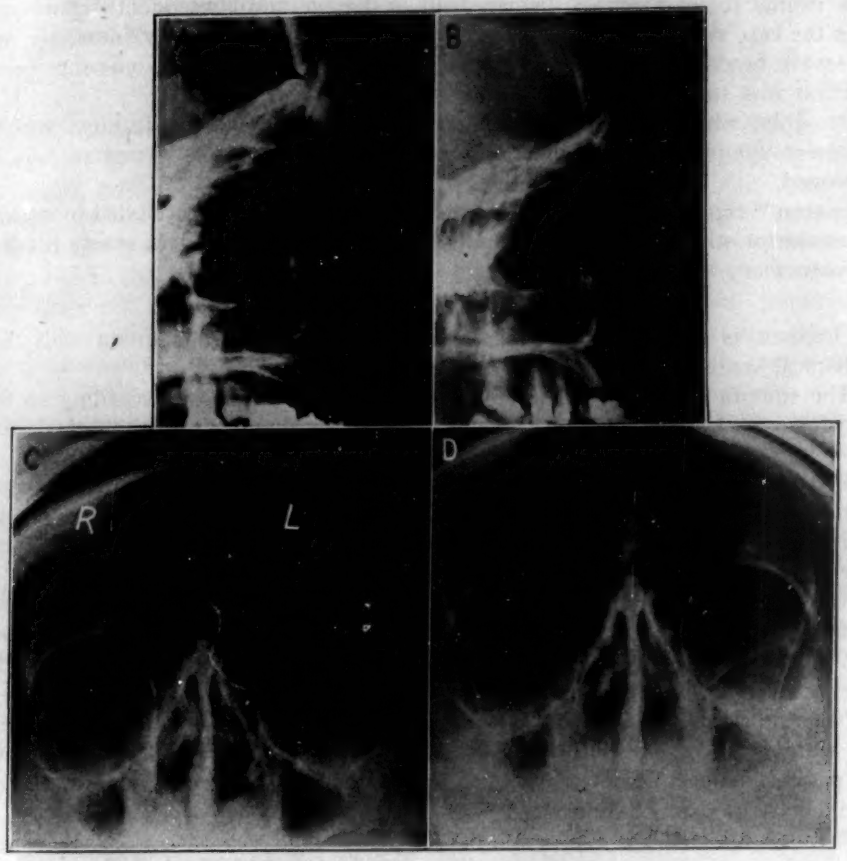

Fig 1.—*A*, roentgenogram made in 1942, showing the attachment of the tumor to the roof of the frontal sinus and the almost complete absence of the anterior wall.

B, roentgenogram made in 1936, showing a slightly smaller growth and less destruction of the anterior wall.

C, roentgenogram made a few weeks before operation, showing a projection extending down into the nasofrontal duct.

D, roentgenogram made four months after operation.

etiologic factor was an activated periosteal embryonal rest at the point where the pedicle was attached to the sinus wall.

7. Cushing, cited by Goodyear, H. M.: Osteoma of Nasal Septum, Arch. Otolaryng. **14**:23 (July) 1931.

SYMPTOMS

Many diagnoses of osteoma are made by routine roentgen examinations of the accessory sinuses of the nose, and there may be no symptoms whatever. Most of the symptoms result from pressure or from obstruction to normal drainage and ventilation of the sinus. Destruction of the posterior wall of the sinus may give rise to alarming neurologic symptoms due to pressure or to infection. Carmody [8] reported such a case in which the right arm, the leg, and the laryngeal muscles became paralyzed.

Destruction of the anterior wall or of the floor of the sinus gives rise to a bulge of the frontal region [8] or to a displacement of the eye and consequent diplopia.

In the case reported here the most prominent symptom was dizziness; the next was severe headache. These two symptoms were so severe that some intracranial condition was suspected (probably pituitary).

Dr. John Shea [9] has observed a series of cases in which dizziness was the prominent symptom. In the majority of cases reported this symptom was not mentioned.

Fenton [10] reported a case in which the nasofrontal duct was occluded by osteoma in an anterior ethmoid cell, the prominent symptoms of which were severe headache and nasociliary neuralgia.

PATHOLOGY

Osteoma is a benign growth, seldom recurs and is malignant only in a mechanical sense. Spontaneous cessation of growth is rare.

The tumors in this group are of 2 main types,[11] classified according to their consistency: (1) compact, ivory-like; (2) soft, cancellous. There are also tumors whose structure is somewhere between the aforementioned extremes. In the case to be reported the specimen was as hard as ivory and much difficulty was encountered in cutting it for decalcification. It is difficult to distinguish a simple hyperplastic growth of bone from true osteoma. Both processes yield dense lamellated bone with few haversian canals (fig. 3) or spongy bone with many vessels and marrow spaces. Osteoma may be found free in the sinus cavity, the pedicle having been separated from its point of attachment (dead osteoma). Sewall [11b] reported such a case. Dead osteoma has been expelled through the nose.[12] The growth of osteoma is slow and there is little in the literature to enable one to estimate the probable rapidity of development. The tumor may reach considerable size. Goris [1] and Hanley [1] each removed a tumor of this type weighing 10 ounces (283.5 Gm.). My patient had been under observation for six years and the roentgen films showing the increase in size are shown in figures 1 and 2.

DIAGNOSIS

Symptoms suggestive of osteoma of the frontal sinus are dizziness, headache and deformity. Roentgen examination gives the most valuable information if the

8. Smith, J. A.: Osteoma of Paranasal Sinuses, Arch. Otolaryng. **15**:152, 1932.

9. Shea, J. J.: Personal communication to the author.

10. Fenton, R. A.: Nasociliary Neuralgia Caused by Osteoma, Ann. Otol., Rhin. & Laryng. **42**:911, 1933.

11. (*a*) Watson, W.: Disease of Nose and Nasal Accessory Sinuses, London, Longmans, Green & Co., 1910. (*b*) Sewall, E. C.: Osteoma of the Frontal Sinus, Ann. Otol., Rhin. & Laryng. **28**:275 (March) 1918; cited by Sprowl, F. G.: Orbito-Ethmoidal Osteoma, with Report of the Case, ibid. **45**:886 (Sept.) 1936. (*c*) Knapp, E.: Osteoma of Frontal Sinus, Arch. Otolaryng. **19**:106 (Jan.) 1934. (*d*) Ewing, J.: Neoplastic Diseases, Philadelphia, W. B. Saunders Company, 1941.

12. Jeschek, J.: Behavior of Frontal Sinus in Osteoma, Arch. Otolaryng. **22**:126 (July) 1935.

tumor has not increased in size sufficiently to cause deformity. It is not always possible to differentiate mucocele from osteoma and at times the two conditions are found in the same sinus. Knapp [11e] reported such a case.

COURSE AND PROGNOSIS

The course of this disease depends on the point and the type of attachment of the tumor, the direction and the rapidity of its growth, and the presence or the absence of an infection of the sinus.

The ultimate extension of the tumor and the destruction it will bring are unpredictable. Secondary infection of osteoma not removed by operation is the chief cause of the high mortality rate of 48 per cent.[12]

TREATMENT

Surgical removal is the only method of dealing with osteoma.[13] This should be carried out as soon as a definite diagnosis is made and the observers are reasonably certain that the symptoms complained of are due to the presence of the new growth in the sinus. Roentgenograms give one valuable information in determining whether or not a lesion diagnosed as osteoma may or may not be giving rise to the symptoms. The finding of a small tumor of this type in a frontal sinus does not mean that surgical intervention should be advised immediately. A yearly check-up with roentgenograms should be made, however, and the tumor should be removed as soon as evidence of pressure is found. The case reported here was followed for six years and the destruction of the wall of the sinus by pressure can be seen in figure 1 *A*. The external plate should be removed so that the interior of the sinus and the point of attachment can be seen. The compact variety with a pedicle can usually be removed without much difficulty. The sessile attached tumor presents a much more difficult problem, as was noted in the 2 cases reported by Coates.[14] If on opening a sinus which contains an osteoma no evidence of infection is found, I do not believe it is advisable to remove more of the lining of the sinus than is absolutely necessary. A snugly fitting catheter can be placed in the nasofrontal duct to permit drainage and prevent infection from entering the sinus from the nose. A study of reported cases leaves no doubt in my mind as to the choice between watchful waiting and early surgical removal. Jeschek [12] expressed the opinion that surgical treatment should be carried out as soon as one is certain that an osteoma is present.

REPORT OF CASE

S. C., a white woman aged 51, was admitted to St. Francis Hospital on Aug. 26, 1942 for diagnosis. Her chief complaint was dizziness and headache.

In 1936 she had severe headaches and was admitted to the hospital for examination. It was thought that pituitary disease might be a factor, and roentgen examination of the sella turcica was made. At that time no consideration was apparently given to the possibility of a sinus condition and no mention is found in the roentgenologist's report of the osteoma which can now be seen in the 1936 film (fig. 1 *B*).

For more than three months the dizziness had been increasing, and the headache was so severe that she was unable to sleep and was very nervous.

The past medical history was not of importance. The patient had undergone appendectomy and drainage of the gallbladder twenty-three years ago and scarlet fever in childhood. In February 1942 she fell and injured her nose. The fractured nasal bones required reduc-

13. Lederer, F. L.: Diseases of Ear, Nose and Throat, Philadelphia, F. A. Davis Company, 1938.

14. Coates, G. M., and Krauss, F.: Osteoma of Frontal Sinus, Ann. Otol., Rhin. & Laryng. 50:450, 1941.

tion and packing for forty-eight hours. Headache was severe at that time and the patient required an opiate to get relief.

Routine laboratory examination, including the Kahn test, gave negative results. The blood pressure was 150 systolic and 100 diastolic. There was no nasal deformity, and there was no evidence of sinus infection. The ears and the larynx were normal. The pupils were round and equal in size and reacted normally. There was no diplopia, the eyegrounds appeared normal and the media were clear.

Vision was 20/25 in both eyes.

There was no external deformity in the frontal region.

Roentgen Examination (Dr. Clifford Jones).—The left frontal sinus was shown to be almost filled with a bony structure which seemed to arise from the roof of the frontal sinus. The other sinuses were clear except for slight thickening of the lining in the right antrum. There was a slight tendency toward hyperostosis of the inner plate of the frontal bone (fig. 1 *A* and *B*). The conclusion was that this probably was osteoma of the left frontal sinus.

Operation.—On September 5 the patient was referred to me by Dr. L. N. Lano for removal of the mass from the left frontal sinus.

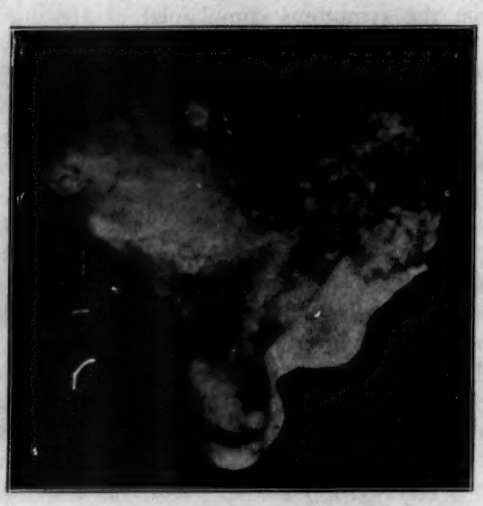

Fig. 2.—Photograph of the growth after removal.

On September 8, with the patient under nitrous oxide–ether anesthesia, an external frontal operation was performed. An incision was made just below the eyebrow, and the periosteum was elevated well above the orbital ridge and into the orbit below the floor of the sinus. It was felt that a good exposure was necessary because of the point of attachment of the tumor.

The anterior wall and the floor of the sinus were as thin as tissue paper, and the orbital ridge was about one-fourth its normal thickness. The pedicle, about 5 mm. in diameter, was attached to the roof and to the anterior wall of the sinus, and the osteoma was removed without difficulty when the overhanging bone was bitten away. The mass appeared much like the half kernel from a large walnut and measured 26 by 24 by 6 mm. There was a round projection below, which fitted snugly into the funnel-like beginning of the nasofrontal duct (figs. 1 *C* and 2). The sinus lining was very thin and was of normal appearance; no secretion was present. The point of attachment of the osteoma was smoothed down with a curet but no attempt was made to remove the lining of the sinus.

In order to permit drainage and also to prevent infection from entering the sinus from the nose, a no. 12 fenestrated catheter was drawn into the nasofrontal duct and anchored to the skin above the sinus. This tube was kept open by gentle suction after injecting a drop-perful of sterile isotonic solution of sodium chloride. The soft tissue was closed with catgut, and the skin was closed with fine dermal sutures. A pressure bandage was applied. The skin healed by first intention and the sutures were removed on the fourth day.

There was no diplopia following the surgical treatment, and the convalescence was uneventful. The patient left the hospital on the fifteenth postoperative day. She has had no dizziness

or headache since the fifth postoperative day. At the time of writing a no. 6 Ritter sound can be passed into the frontal sinus without difficulty. A postoperative roentgenogram is shown in figure 1 *D*. The tumor consisted of ivory-like bone. A photomicrograph is shown in figure 3.

Microscopic Observations (Dr. W. V. Knoll).—The cortical surface of the tumor consisted of compact lamellas, which were arranged concentrically and were parallel to the surface of the tumor. The bone was in the main remarkably solid and was of the eburnated type of tissue (fig. 3). Haversian systems were rare and irregular, but bone corpuscles were present. Toward the center of the tumor the tissue was less compact, and a few patches showed a trabecular type of arrangement. There was no periosteal covering over the tumor. The diagnosis was compact (eburnated) osteoma of the frontal sinus.

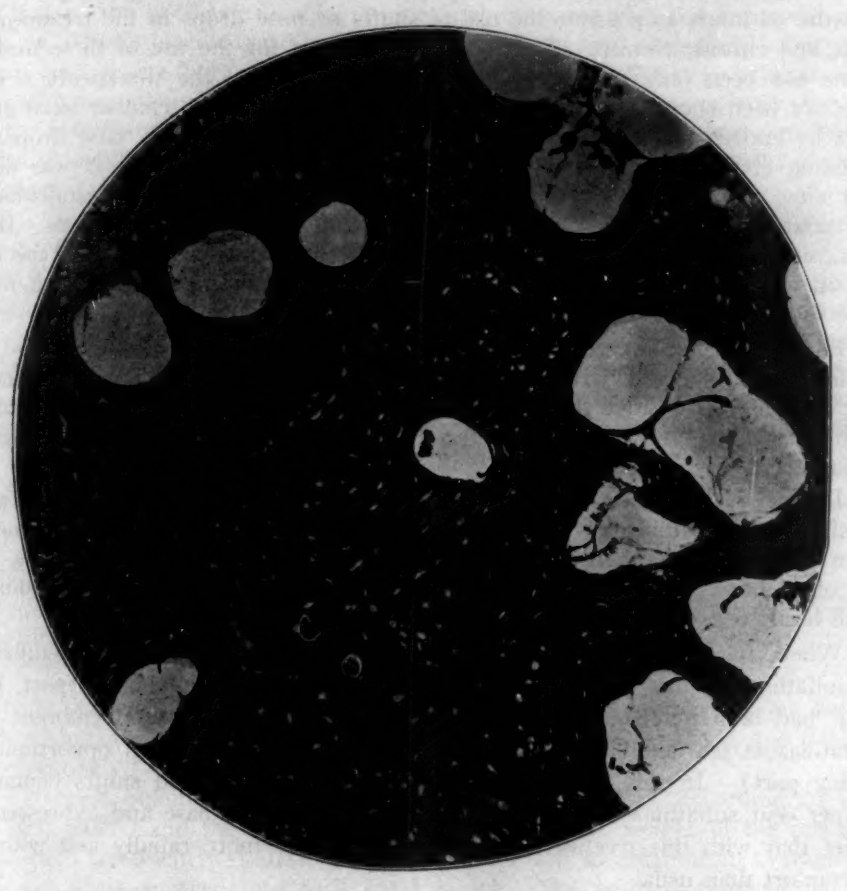

Fig. 3.—Photomicrograph of the osteoma.

COMMENT

Although this patient was under observation for six years, the diagnosis of the tumor was made only a month before operation. The roentgenograms give some idea of the very slight but perceptible increase in size in six years. The seldom mentioned symptom of dizziness was the most pronounced one in this case. There was no external deformity, and the relief of symptoms was prompt after the removal of the tumor.

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LOCAL TREATMENT OF ACUTE RHINITIS WITH SULFATHIAZOLE

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During the last fifteen years of my practice as an otorhinologist I have tried to avoid as much as possible the use of snuffs or nose drops in the treatment of acute and chronic rhinitis. The theoretic argument for the use of these medicaments has been only a little convincing, and in general the therapeutic results have not been encouraging. As a rule, I have endeavored to combat nasal infections by entirely different methods and have made use of snuffs, nose drops and penciling of the nasal mucous membrane only on rare occasions. It was therefore after much hesitation that I persuaded myself to begin the insufflation of sulfathiazole into the nasal cavities in treatment of inflammatory conditions. However, since good results had been announced from so many quarters in the local treatment of infection with this agency, from which toxic effects were rarely observed, I at last overcame my doubts.

Before I began the treatment of my patients with sulfathiazole, I tried the medicament on myself. I insufflated sulfathiazole powder into my nose once a day for four consecutive days. I did not have the least indication of irritation, such as sneezing, or feel the slightest discomfort immediately after insufflation, or later.

I have even treated inflammatory conditions of the nose other than acute rhinitis with sulfathiazole. However, as yet the results in cases of such disorders have not been better than those which I have obtained with earlier methods. On the other hand, the results of local treatment of acute rhinitis with sulfathiazole have been so good that I consider them well worth reporting.

When, in February 1942, I began to treat acute rhinitis with insufflations of sulfathiazole, this method was not new in principle. Only one report, however, had been published on the treatment of the nasal mucous membrane with sulfathiazole powder[1] (an investigation in which I later had an opportunity of taking part). In this study Delafield and his associates used snuffs containing 10 per cent sulfathiazole with magnesium carbonate as a base and expressed the belief that with this treatment acute rhinitis cleared more rapidly and with less discomfort than usual.

The next year Richtnér[2] published 30 cases of acute rhinitis in which he treated the condition by spraying sulfathiazole into the nose. At the same time, he treated the disease in another 30 cases by instilling a solution of azosulfamide and ephedrine (3 per cent solution of azosulfamide and 1.5 per cent ephedrine sulfate) into the nose. He concluded:

> Since altogether not more than about 30 cases are available in each group, it is as yet too early to make any definite statement regarding the result, but the general impression is that the effect of sulphathiazole is superior to that of nasal drops as far as the length of time of healing is concerned, and probably also with regard to the bacteriostasis.

1. Delafield, M. E.; Straker, E., and Topley, W. W.: Brit. M. J. **1**:145 (Feb. 1) 1941.
2. Richtnér, N.: Acta oto-laryng. **30**:311 (July-Aug.) 1942.

PRESENT STUDY

I treated 92 patients with acute rhinitis between Feb. 18 and Nov. 21, 1942. With the aid of an insufflator, enough sulfathiazole was sprayed into each nasal cavity so that the visible mucous membrane was covered with a thin coating of the powder. This was usually repeated once a day, or every other day, until the inflammation subsided, which usually happened after three to five days.

The insufflator (probably a Kabiersky model) which I use has a blowpipe with a 3 mm. bore; additional blowpipes in use have a bore of 5 mm. at the back and 3 mm. at the front. This bore is, according to my experience, much larger than that of the ordinary insufflator pipe, and this simplifies the treatment considerably. Sulfathiazole readily becomes slightly lumpy (especially if it gets damp), and if the bore of the blowpipe is not sufficiently large, the powder will not come out in a steady stream, so that the passage is completely stopped and the insufflator put out of action. With a sufficiently large bore one has a greater possibility of insufflating a uniform amount of sulfathiazole at each treatment.

It is clear that one cannot spray exactly the same amount of sulfathiazole at each insufflation. However, in order to find out approximately how large a quantity of powder was insufflated into each nasal cavity at each treatment, I had Karling, a Göteborg chemist, compile the following table of weights. After the insufflator had been weighed together with the powder, I sprayed into the air about as much powder as I usually blow into both nasal cavities at each treatment. Subsequently the insufflator was weighed, and this procedure was repeated ten times. After a few weeks, during which I had treated patients by insufflation of similar amounts of sulfathiazole, twenty more weighings were made in the same manner. The following values, expressed in grams, were obtained.

First Weighing, Gm.		Second Weighing, Gm.			
0.0463	0.0650	0.0308	0.0501	0.0163	0.0206
0.0535	0.0630	0.0349	0.0365	0.0233	0.0202
0.0760	0.0297	0.0432	0.0173	0.0134	0.0192
0.0550	0.0591	0.0289	0.0293	0.0156	0.0424
0.0450	0.0562	0.0164	0.0272	0.0224	0.0306

Finally, two additional weighings were made, this time the powder being insufflated into the nasal cavities of 2 patients; the values were 0.0311 and 0.0274 Gm. respectively.

The largest quantity of sulfathiazole insufflated was thus, according to the weighings, 0.0760 and the least 0.0134 Gm. The average weight of the powder used in each treatment was 0.0327 Gm. Thus, at each insufflation an average of 0.0164 Gm. was sprayed into each nasal cavity. The patients received on an average three and a half insufflations into both cavities during the course of an average period of treatment of four and twenty-two hundredths days. The amount of sulfathiazole administered to each patient during the course of a period of treatment thus averaged 0.12 Gm. The amount of sulfathiazole insufflated into the nose is infinitesimal as compared with the quantity prescribed for oral administration in treatment of certain infectious diseases. That a toxic effect would arise on account of resorption of sulfathiazole by the nasal mucous membrane is exceedingly improbable. Not one of the patients whom I have treated for acute rhinitis has shown any symptom which could be ascribed to a toxic effect of the drug.

Neither have I been able to observe any change in the nasal mucous membrane which owes its occurrence to an injurious local effect of sulfathiazole. According

to Richtnér's aforementioned detailed and interesting research, no deleterious effect was expected or observed. As previously stated, the treatment was usually repeated each day. Not once could I perceive, during the repeated insufflations, any remains of sulfathiazole in the nose from earlier sprayings.

All age groups, were represented among the 92 patients I treated: Five were under 1 year of age; 8 were between 1 and 5 years old; 10, between 5 and 15 years, and the rest, between 15 and 81 years of age.

Seventy-nine of the patients had previously been treated by me, or by another physician, for disease of the ear or the air passages which had made its first appearance with acute rhinitis. Thus, 11 patients had previously been treated for recurrent infection of the throat and/or bronchitis; 42, for otitis, salpingitis and/or recurrent infection of the throat, and 21, for sinusitis and/or otitis (of whom 7 had been operated on for mastoiditis), while 5 had undergone operation for recurrent nasal trouble (resectio septi nasi). For fear of a repetition of such complications, these patients had sought medical help for what appeared to be "banal" rhinitis, in the hope that something could be done to prevent the complications. All these patients recovered without incident.

Twelve of the 92 patients, because of their occupation or profession (singing, acting or public speaking), were particularly dependent on the condition of the vocal cords and resonance cavities and thus feared complications not only from acute but from banal rhinitis. All these patients were treated in the same way and recovered without complication or interruption of their work. A small number of persons consulted me for relief of banal rhinitis who did not belong to any of the aforementioned categories. These patients also quickly recovered after insufflation of sulfathiazole.

The number of patients whom I treated is not large enough to justify conclusions concerning the curative effect of insufflation of sulfathiazole on acute rhinitis. However, it is remarkable that not one of the patients with this condition has had any complication and that most of the patients have been cured in a shorter time than is usual with this disease.

In none of the patients treated did the inflammatory condition in the nose produce all the stages characteristic of acute rhinitis. The feeling of irritation and fulness of the nose, sneezing, etc., were nearly always almost instantly relieved. The obstruction of the nose was generally so lessened that the patient was little inconvenienced by it. The thin, fluidlike secretion present in the nose in the earlier stages of the infection was in most patients quickly and notably relieved. In a number of patients the secretion became phlegmonous or phlegmopurulent after a few days. In some cases this stage was rather protracted, up to a few weeks, before the secretion disappeared, although it did not cause any troublesome stuffiness or other great discomfort.

COMMENT

Even if the treatment of acute rhinitis by insufflation of sulfathiazole has so far given remarkable results, it is too early to draw any definite conclusions as to the value of the therapy. In addition to insufflation, those methods of treatment, especially the prophylactic, but even the curative, which are already in use ought still to be employed if their rationale is acceptable and they have given satisfactory results. Everything indicates that it is not yet fully known how preparations of sulfanilamide work. With insufflation of sulfathiazole in the treatment of acute rhinitis a biologic process is encountered the details of which

are not completely familiar. Perhaps its action may not be without serious consequences to the patient (e. g., with regard to the conditions of immunity). Insight into this problem ought to be gained by observations over a long period on a large number of patients.

Delafield and his collaborators [1] observed only a small number of patients, as did Richtnér.[2] This may be explained by the fact that few persons go to a physician when they have the exceedingly common acute rhinitis. However, if professional colleagues will report their experiences with the method, the number of control cases should rapidly increase.

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FLUID IN THE MIDDLE EAR

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The removal of an accumulation of nonpurulent fluid in the middle ear is a common otologic problem. There is no doubt that in the great majority of cases of catarrhal otitis media the condition resolves spontaneously or responds to simple therapeutic management. This paper is primarily concerned, however, with the occasional recalcitrant case in which accumulated fluid presents a stubborn front to all the various remedies at the disposal of the otologist. In these difficult cases the fluid is apparently incompletely removed or accumulates more rapidly than it is emptied.

Permanent evacuation of all excess fluid is necessary in order to avoid secondary degenerative changes. These possible alterations include chronic fibrous narrowing of the eustachian tube, permanent retraction of the membrana tympani, with or without adhesions to the promontory, and varying degrees of impairment of hearing commonly described as chronic catarrhal deafness.

DIAGNOSIS OF FLUID IN THE MIDDLE EAR

The diagnosis of nonpurulent fluid in the middle ear is usually not difficult for the experienced otologist. The patient complains of a feeling of fulness, numbness or heaviness in the ear, frequently associated with tinnitus. Autophony is a common symptom. Hearing is usually diminished, but not to the extent that it would be if the fluid were purulent.

Objectively, the membrana tympani is usually retracted, sometimes conspicuously so. There is often a streak of congestion just posterior and parallel to the handle of the malleus. The fluid in the middle ear gives the drum membrane a gray-yellow hue and forms a level that can be seen through the translucent membrana tympani as a black hair line, which frequently forms a scalloped meniscus centering at the umbo. If the head is shifted forward or backward, this meniscus also shifts after a time lag which varies with the degree of retraction of the drum membrane and the viscosity of the trapped fluid. When the drum membrane is drawn outward with a Siegle otoscope the level of the fluid drops because the middle ear space is thereby widened. Occasionally the fluid collects in a small triangular space, as if locked off in a pocket of adhesions.

When the eustachian tube is catheterized and inflated, the auscultation tube conducts to the examiner a moist, rattling sound, and the passage of air into the middle ear occurs in interrupted spurts, as if the air stream were intermittently closed off by a valve. If inflation is successful, the patient's symptoms are usually relieved at once, and this relief persists for a varying length of time, the period depending on the severity of involvement. In some cases little symptomatic relief is experienced even though inflation is apparently successful. This is probably due to incomplete evacuation of the fluid.

COMMON CAUSES OF FLUID IN THE MIDDLE EAR

Impaired function of the eustachian tube is by far the most prominent cause of accumulation and retention of nonpurulent fluid in the middle ear. The

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eustachian tube is a slitlike, potential tube which is normally closed, with the walls apposed. Any pathologic process which impairs its potential patency also disturbs its physiologic function of drainage and ventilation of the middle ear.

The commonest cause of blockage of the eustachian tube is congestion and inflammation of the mucosa of the lumen. This condition is known as eustachian salpingitis. After the tube is blocked, the constant absorption of air by the mucous membrane lining the middle ear, mastoid cells and tubal cavity creates a pressure lower than atmospheric, and this establishes a vicious circle by inducing increased swelling of the tubal mucous membrane and sooner or later leads to the phenomenon of transudation or exudation.

Eustachian salpingitis is usually secondary to, or concurrent with, a nasal or nasopharyngeal pathologic condition. The various common etiologic factors, alone or in combination, which are frequently responsible for initiating disturbances in the physiologic processes of the tube are listed, with a short outline of the corrective procedures recommended.

1. *Lymphoid Tissue in the Nasopharynx.*—This factor is a most important one and is frequently missed as the primary cause of blockage of the eustachian tube. Too often the nasopharynx is not examined carefully enough if the patient gags easily and the examiner's time is limited. It is relatively easy to detect a large midline adenoid mass which occludes the torus opening. Often, however, there is no large central mass, but much trouble may be caused by lymphoid hyperplasia in the fossa of Rosenmüller, which effects pathologic closure of the tube by compressing the posterior lip or by reducing the efficiency of the dilator muscles. Less often there may be intratubal lymphoid tissue. The torus is occasionally degenerated to a flabby mass, which completely occludes the opening.

Aside from simple pressure effects, lymphoid tissue may influence the function of the tube by other means. Inflammation of this tissue is a constant source of contiguous irritation to the mucous membrane of the torus, and frequently the development of scar tissue in such a condition will seriously narrow the eustachian orifice and prevent proper function of the dilator muscles. Again, in some instances, the nasal discharge swept posteriorly by the nasal cilia "hangs" on the lymphoid clumps and is held more or less in place against the torus, with consequent irritating effect.

Treatment should consist of removal of the lymphoid tissue by means of irradiation or surgical measures or both. Radiation treatment is the method of choice for the lymphoid hyperplasia in and around the fossa of Rosenmüller. However, the complete elimination of a large central mass of adenoid tissue by means of radium or roentgen treatments alone is frequently disappointing because the fibrous element secondary to chronic inflammation is so prominent. A combined procedure, consisting of surgical removal of a large midline adenoid mass with a curet, followed by irradiation to reduce the diffuse hyperplastic element, is frequently necessary to obtain a completely normal nasopharynx.

If a malignant new growth is suspected, a specimen should be taken for biopsy before any radiation is administered.

2. *Rhinitis or Rhinosinusitis.*—The mucous membrane of the eustachian tube is continuous with that of the nasopharynx and the posterior nasal passages. It is unlikely that the nasal mucous membrane could be inflamed without some concurrent involvement of the mucous membrane of the eustachian tube. In addition, the nasal cilia sweep all nasal debris directly past the opening of the tube. Frequently, symptoms of eustachian salpingitis can be relieved only after the pathologic focus in the nose is eradicated.

Treatment of acute and subacute sinusitis should consist of general and local measures directed toward improving the ventilation and drainage of the nasal passages. The patient's environment should be warm, but not uncomfortably hot. The use of plain steam in the room is desirable, but a relative humidity above 90 per cent serves no useful purpose and merely adds to the patient's discomfort. Vasoconstrictors, such as ephedrine or neo-synephrin in isotonic solution of sodium chloride, should be used at regular intervals. Bulky nasal packs are unnecessary and usually cause harmful trauma; a small amount of simple vasoconstrictor medication carried into the middle meatus or the ethmosphenoid recess by a delicate, cotton-tipped applicator will prove much more efficacious than heavy packs in reaching the sinus ostiums. Voluminous douching of the nasal passages is contraindicated. The patient should be encouraged to draw the nasal secretions backward toward the nasopharynx rather than blow the nose to excess. If pus is believed to be pooled in the antrum or the sphenoid sinus, irrigation of these sinuses with isotonic solution of sodium chloride is in order. The Proetz displacement treatment is at its best in cases of the subacute form. If polyps interfere with proper drainage, they should be carefully removed. A hypertrophied posterior tip of the inferior turbinate should be removed with a polyp snare if it is of sufficient size to encroach on the torus opening. In some cases of sinusitis the cause is a focus of dental infection, and if such a diagnosis is established beyond doubt by examination and roentgenograms, the diseased teeth should immediately receive suitable treatment. The use of sulfonamide compounds locally and systemically gives considerable promise but is still in the stage of development and evaluation.

3. *Allergic Rhinitis.*—The mucosa of the eustachian tube is frequently turgescent, its condition paralleling that of the nasal mucous membranes in this respect. In addition, the output of mucus is greater than that of normal mucosa; this adds to the problem of drainage.

The treatment of allergic rhinitis should consist of desensitization or avoidance, if possible, of the specific causes, if the latter can be determined. If specific diagnosis and immunization fail, palliative therapy with ephedrine and other drugs may have to be resorted to.

4. *Improper Blowing of the Nose.*—Excessive and harsh blowing of the nose is all too common. Admittedly, the presence of excessive nasal secretions can be unpleasant, and blowing offers considerable relief. Whereas, however, 75 per cent of the excess secretion can be expelled by one unit of blowing effort, each successive unit of such effort succeeds only in emptying a rapidly decreasing increment of secretion, with increasing traumatic effect on the nasal and tubal mucous membrane. Contrary to popular belief, it is unlikely that mucus or pus can be "blown" directly into the tube unless there is a perforation of the membrana tympani. Experiments with a small piece of cork and a test tube show that air blown into a closed tube tends to remove the foreign body rather than push it farther inward, toward the closed end. Violent blowing of the nose probably does most of its damage by increasing tubal congestion, with attendant blockage of the lumen.

5. *Dental Malocclusion.*—Poor dental occlusion frequently results in disturbance of function of the temporomandibular joint. If the condyle is displaced posteriorly, the eustachian tube is subjected to pressure trauma. Such a condition should be treated by application of corrective orthodontic procedures.

6. *Sudden Changes in Altitude.*—The factor of the physical effect of rapid decreases in altitude is playing an increasingly prominent role. The slitlike nature

of the eustachian tube does not allow it to adjust to sudden changes in air pressure with the facility of the semirigid external auditory canal. Cases presenting the most difficulty are usually those with an element of acute or chronic narrowing caused by factors described in the preceding paragraphs. Sudden changes in air pressure will cause a flabby tubal mucous membrane to act as a flap valve and completely close off the tube, a condition leading to the clinical entity which Armstrong named areo-otitis-media. If areo-otitis reaches a subacute or a chronic phase, accumulation and retention of fluid in the middle ear are frequently an important part of the syndrome.

PRESENT STATUS OF TREATMENT

Undoubtedly, in many cases of acute accumulation of nonpurulent fluid in the middle ear the disturbance clears spontaneously without benefit of medical care. As acute inflammation subsides, the mucosal congestion diminishes sufficiently for ventilation and drainage of the middle ear to be reestablished. However, in some cases the condition "clears up" only in the sense that the symptoms are gradually, but only partially, relieved. This is more likely to happen in the case of an insensitive person who accepts the modified function as adequate and forgets about it for the time being. In such cases there may develop the permanent retractions of the membrana tympani and the chronically narrow eustachian tubes with chronic adhesive catarrhal deafness so frequently seen by the otologist in cases in which there is no history of inflammatory disease of the ear. In these cases the "natural cure" is obtained at the cost of permanent damage to hearing.

Treatment of fluid in the middle ear consists of measures directed toward reestablishment of the potential patency of the eustachian tube, so that ventilation and drainage of the tube and the middle ear are possible. This is accomplished in the majority of cases by dilation of the tube with air by means of simple politzerization. If air cannot be introduced through the tube into the middle ear by this means, one must catheterize and inflate the tube. The use of a good nasopharyngoscope in the opposite nostril helps immeasurably in the delicacy and accuracy of this procedure. The air thus introduced renders the eustachian tube patent, restores the normal air pressure in the middle ear and is usually successful in driving accumulations of fluid out of the middle ear and eustachian tube (fig. 3). Several treatments are usually sufficient to clear the middle ear and improve the tubal patency.

Cases in which the eustachian tube is markedly occluded, so that safe introduction of air into the middle ear is prevented, present a difficult problem. Occasionally, preliminary inflation by politzerization will simplify introduction of air with a catheter. Some otologists advise cautious dilation with eustachian bougies as a preliminary procedure in cases of obstruction, but great care should be taken to avoid trauma to the delicate mucous membrane lining of the tube.

TREATMENT OF RESISTANT CONDITIONS

The cases in which the condition offers resistance to treatment can cause the otologist considerable difficulty. In such cases the fluid either is incompletely removed or accumulates more rapidly than it is emptied. In some instances the membrana tympani remains greatly retracted after successful tubal inflation and appears to be bound by fresh synechial adhesions to the mucosa of the promontory. In such cases a small triangular collection of fluid (fig. 4) sometimes persists along the lower half of the cavity of the middle ear and in the hypotympanic cells even

after the greater portion of the fluid is expelled by catheterization and inflation. In cases in which such resistance is encountered, it is necessary to eliminate any etiologic factors responsible for initiating and maintaining disturbances in physiologic processes of the tube. Such factors have been discussed earlier in this paper. For direct treatment most otologists recommend incision of the membrana tympani combined with inflation by means of catheterization. Others incise the drum membrane and remove the fluid by employing suction directly with a cannula or massively with the Siegle otoscope or the Delstanche pump. Frequently, if tubal patency can be thereafter maintained, these procedures have a dramatic effect; the fluid is completely expelled, and the incision in the drum membrane immediately heals. However, too often the mucosa of the middle ear, mastoid cells and tube

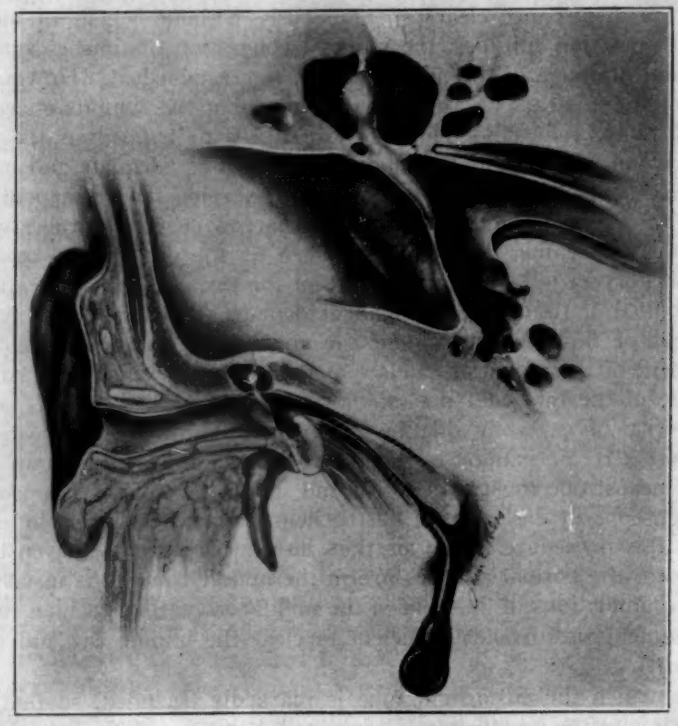

Fig. 1.—The pharyngeal, or cartilaginous, portion of the eustachian tube is normally closed except during swallowing, yawning and similar actions. The catheter placed into the ostium fits more or less snugly.

continues to secrete more fluid than the drainage facilities of the eustachian tube can handle, and the patient returns in several days with the same condition that was present when he first appeared for treatment. Repeated incisions are thus necessary with such patients, and both physician and patient may feel discouraged. The practice of making a deliberate circular cut in order to obtain a permanent perforation of the drum membrane is mentioned, only to be condemned as an unnecessarily drastic procedure which may lead to permanent damage to hearing.

What, then, is to be done in the difficult case with fresh drum-promontory adhesions, trapped fluid and annoying symptoms which remain after the physiologic condition of the tube has been improved and all etiologic factors have been corrected?

I wish to describe a method of treatment which has proved useful in my hands. This treatment avoids incision of the membrana tympani and is based on the following principles: The pharyngeal, or cartilaginous, portion of the eustachian tube is normally closed except during swallowing, yawning and similar actions (fig. 1). Inflation of the eustachian tube with a catheter gives rise to the play of two forces, one dilating and the other cleansing. The first portion of air blown into the tube creates enough pressure to dilate partially the eustachian tube and enter the middle ear space. The catheter placed in the ostium of the eustachian tube fits snugly, and air subsequently blown into the tube cannot escape until sufficient pressure has been developed in the closed system to dilate further the flexible lumen of the tube and allow the air to make an exit around the sides of the catheter tip (fig. 2). The pressure thus developed in the tube and middle ear

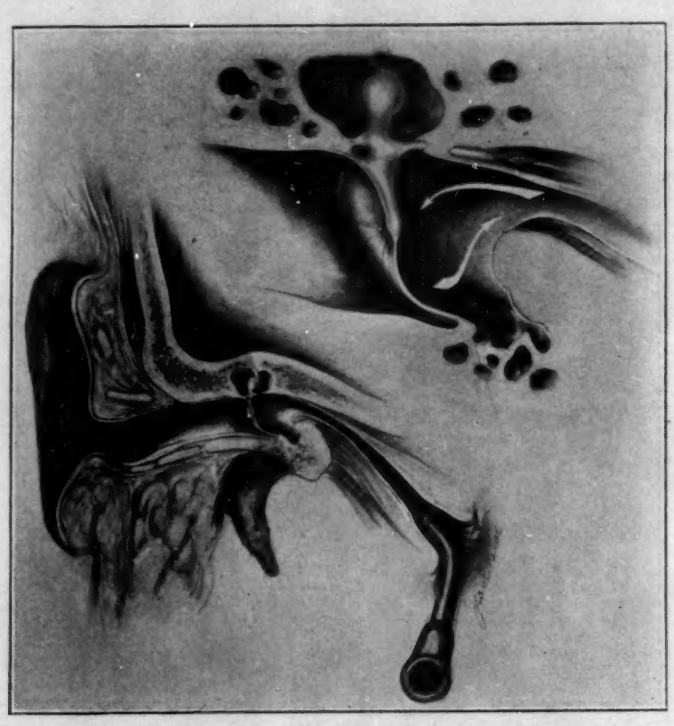

Fig. 2.—Air blown into the eustachian tube cannot escape until sufficient pressure has been developed in the closed system to dilate further the flexible lumen of the tube and allow the air to make an exit around the sides of the catheter tip. The membrana tympani is pushed outward, with consequent widening of the middle ear space.

space incidentally enlarges the otherwise rigid cavity of the middle ear by pushing outward its only flexible portion, the drum membrane (fig. 2). It is thus easy to see why passage of air into the eustachian tube with a catheter is so efficacious in treatment of ordinary cases of fluid in the middle ear. The eustachian tube is dilated; the ear drum is pushed outward, and the stream of air sweeps the fluid from the middle ear space and expels it around the sides of the catheter (fig. 3).

However, when either gluelike exudate or inflammatory synechial adhesions bind the membrana tympani to the promontory, the amount of air pressure required to dilate the eustachian tube sufficiently to allow escape of the air stream may not be sufficient to push the drum membrane outward. In cases of this type a

portion of the fluid is expelled, but the membrana tympani either remains in the retracted position or puffs out in blister-like portions and is still held to the promontory at various points. Pocket-like spaces are thus created from which the fluid is expelled with difficulty (fig. 4).

Incision of the membrana tympani in these cases may result in evacuation of the fluid but, obviously, cannot correct the adhesions and the associated retraction. Occasionally a further increase in air pressure can break the adhesions, but here one runs the risk of damage to the mucosal walls of the eustachian tube, with subsequent peritubal emphysema.

In such difficult cases it seems logical to shift the membrana tympani outward by means more efficient than inflation of the eustachian tube. Negative pressure in the external auditory canal, accurately measured and controlled, can suitably

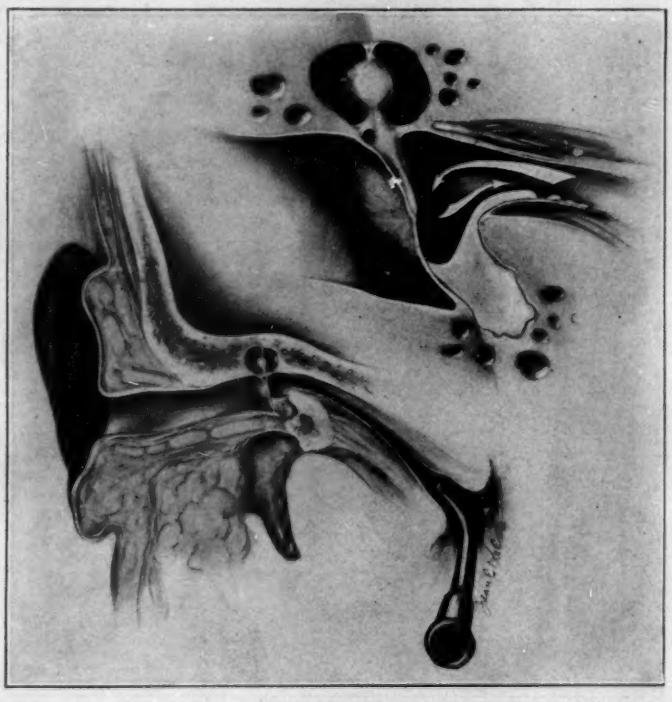

Fig. 3.—In simple cases of accumulation of fluid in the middle ear inflation of the eustachian tube with a catheter dilates the tube and pushes the drum membrane outward, and the stream of air sweeps the fluid from the thus widened middle ear space and expels it past the sides of the catheter.

achieve this purpose (fig. 5). By this procedure the air stream entering the eustachian tube through the catheter is relieved of the responsibility of pushing the membrana tympani outward and has only to dilate the eustachian tube and expel the fluid from the temporarily enlarged middle ear space through the eustachian tube into the nasopharynx.

The basic principle for the use of measured and controlled negative pressure in the external auditory canal for this purpose differs completely from that involved in the practice of suction for aspiration of fluids in the middle ear after incision of the membrana tympani. Nor should it be confused with pneumomassage of the drum membrane by alternate suction and pressure in the external auditory canal.

Method of Treatment.—The only special apparatus not ordinarily present in the otologist's office is a 1,000 cc. glass chamber and a small altimeter.

A Siegle speculum (fig. 5) is placed in the external auditory canal with care to get an airtight fit. A speculum with a bulbous tip, as illustrated, is best suited for this purpose. The air hose from the speculum, instead of leading to a hand bulb, is fitted to a 1,000 cc. glass chamber, from which air can be exhausted with ordinary water suction. An altimeter, so placed in the chamber that its dial can be easily observed through the glass walls, is used to measure the amount of negative pressure in the combined chamber and external auditory canal system.

First, the nasal passage is anesthetized, so that catheterization of the eustachian tube is made painless. The pressure in the chamber and external auditory canal system is then reduced by having the nurse slowly apply suction at tube *A* (fig. 5) until the proper degree of vacuum is achieved. The negative pressure desired is that which is adequate to draw the membrana tympani outward sufficiently for the contour of the fluid meniscus in the middle

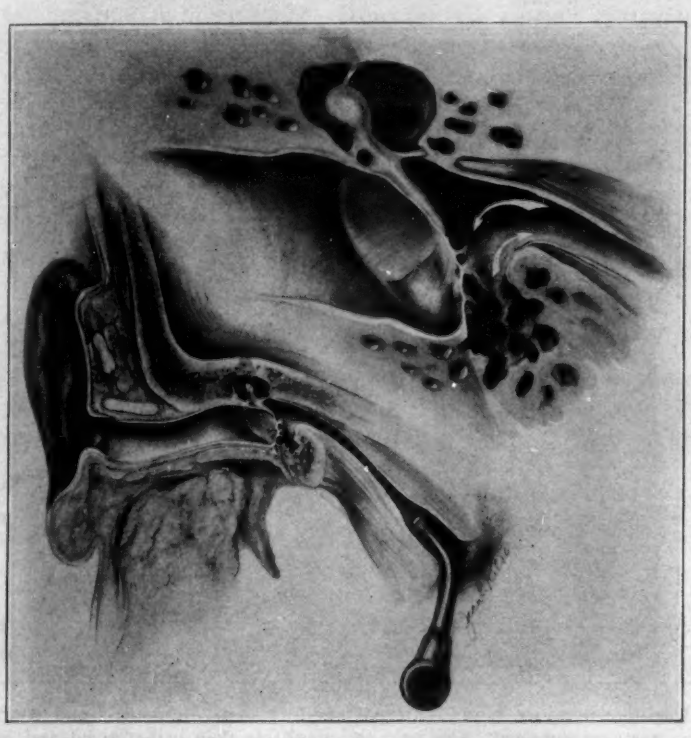

Fig. 4.—Gluelike exudate or synechial adhesions cause formation of pockets, from which the fluid is incompletely expelled. The air pressure required to dilate the eustachian tube is frequently insufficient to push the drum membrane outward when it is thus bound to the promontory. Notice the triangular collection of trapped fluid, as visualized through the translucent membrana tympani.

ear to be lowered significantly as observed through the Siegle window. Unless previous examination of the membrana tympani has revealed decided stretching or disclosed a weak area over an old perforation, it is safe to exhaust the air in the patient's external auditory canal to a pressure equivalent to the atmospheric pressure at a height of 1,000 to 4,000 feet (0.3 to 1.2 kilometers). The ease with which the membrana tympani is drawn outward varies with the decrease in pressure in the middle ear and, also, with the extent of chronicity of the adhesions binding the drum membrane to the promontory.

When the air pressure in the external auditory canal has been reduced to the desired level, as previously described, the reading of the altimeter dial is noted, and this state of optimum reduced pressure is now maintained at a constant level by closing pinchcock *B*

(fig. 5) and by instructing the patient to hold the Siegle tip without moving. If no leak is present, the altimeter dial will remain steadily at the height desired. The eustachian tube is then carefully catheterized (I prefer nasopharyngoscopic vision for accuracy), and air is blown into the tube in a constant stream while the patient repeats swallowing motions. This concludes the treatment. The catheter is removed from the nose, and air is allowed slowly to enter the chamber and external auditory canal system by opening valve *B* until the dial of the altimeter again registers the atmospheric pressure at sea level. Finally, the Siegle speculum is removed from the external auditory canal.

As stated previously, by the use of this procedure the air column entering the eustachian tube via the catheter is relieved of the responsibility of pushing the membrana tympani outward and has only to dilate the eustachian tube and expel the fluid from the now adequately enlarged middle ear space, in which partitions and pockets of adhesions have been eliminated or reduced to a minimum.

Fig. 5.—Negative pressure in the external auditory canal, measured and controlled, draws the membrana tympani outward. The eustachian tube is then catheterized and inflated in the routine manner, while this reduced pressure is maintained at a constant level, as indicated by the reading of the altimeter dial. The membrana tympani is not incised.

RESULTS OF TREATMENT

The first clinical applications of the method were limited to difficult cases. Results for the most part have been satisfactory in cases of the acute and subacute type. Typical of this group is the case in which a residual amount of fluid is seen to be trapped in a triangular adhesion pocket even after the eustachian tube has been successfully catheterized and inflated. One treatment frequently gives immediate subjective relief and objective improvement in cases of the subacute type in which symptoms have not been present more than a month or two. In such instances remarkable improvement in patency of the eustachian tube frequently appears as an outstanding feature at a subsequent treatment.

Success with chronic conditions, those of four months' duration or more, has been more variable. The eustachian tube is often greatly narrowed by irreversible fibrous changes and frequently does not allow the passage of an adequate air stream when inflation with a catheter is attempted. Adhesions binding the drum membrane to the promontory present another serious difficulty. The longer the duration of the patient's symptoms, the greater the probability that the original granulation synechia have been converted into fibrous adhesions. If the drum membrane is drawn outward tension is exerted on these adhesions, and if the latter are relatively fresh the membrana tympani may be easily torn from the mucosa of the promontory. The extent to which the drum membrane can be safely pulled outward, and consequently the amount of tension which can be exerted on the adhesions, varies directly with the amount of negative pressure created in the external auditory canal. However, the amount of negative pressure which is safe to use in the external canal depends on the strength of any one portion of the ear drum. It follows that if the adhesions are stronger than the drum membrane or any part of the membrane, any safe amount of tension on the drum membrane will be insufficient to break the adhesions. Even under these circumstances portions of the drum membrane can be safely drawn outward, and this frequently allows the fluid to be emptied by the air stream from the catheter when the tube is inflated. The removal of the fluid can give partial relief, even though the adhesions remain for the most part intact and the retraction persists.

SUMMARY AND CONCLUSIONS

1. A method is presented for treatment in difficult cases of accumulation of nonpurulent fluid in the middle ear. Incision of the membrana tympani is avoided.

2. The outstanding common etiologic factors which are frequently responsible for initiating physiologic disturbances in the tube are briefly discussed. Careful elimination of any of these factors, if present, is an important adjunct to the treatment of accumulation of fluid in the middle ear and in the prevention of recurrence of such a pathologic condition.

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ATRESIA OF THE EXTERNAL AUDITORY CANAL

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Although atresia of the external auditory canal is not common, it is seen with sufficient frequency to merit more consideration than is devoted to it in textbooks and reference books on otology and plastic surgery.

Beck, in an article in the textbook of Jackson and Coates,[1] dismissed the subject with this brief statement:

> The variety of defect or deformity [of the external ear] will range from a closure by a diaphragm of the canal or a small tubercle on the pinna to complete absence of the auricle and a complete obliteration of the canal.

Ballenger and Ballenger[2] devoted two pages to the subject and quoted extensively from Richards.[3] Morrison[4] referred his readers to Joseph's[5] book on plastic surgery for a detailed description of the condition and its correction, but reference to this text reveals an extreme paucity of information! Barsky[6] stated:

> . . . The simplest method of restoring the external auditory canal, the absence of which is due either to atresia, the result of trauma, or to microtia, is to dissect a canal following the course of the old one, excising scar tissue if necessary, and then utilizing an intermediate skin graft wrapped about a stent mould.

Reference to the journal literature is hardly more illuminating. Dean,[7] in 1917, presented a thorough review of the cases up to that time and reported a case of bilateral atresia, without abnormality of the auricles, in which operation was successful. In 1931 Fraser[8] reported 15 cases from the Royal Infirmary of Edinburgh and presented an extensive review of the records in the literature, as well as a thorough study of the histology and pathology of the congenital type of atresia. Richards[3] read an elucidating report on congenital atresia before the Eastern Section of the American Laryngological, Rhinological and Otological Society, Inc. He presented a detailed description of the embryonic development

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From the Department of Otolaryngology of the Baltimore Eye, Ear and Throat Charity Hospital.

Read at a meeting of the Southern Section of the American Laryngological, Rhinological and Otological Society, Inc., Chattanooga, Tenn., Jan. 28, 1943.

1. Jackson, C., and Coates, G. M.: The Nose, Throat and Ear and Their Diseases, Philadelphia, W. B. Saunders Company, 1930.

2. Ballenger, W. L., and Ballenger, H. C.: Diseases of the Nose, Throat and Ear, ed. 7, Philadelphia, Lea & Febiger, 1938.

3. Richards, L.: Congenital Atresia of the External Auditory Meatus, Ann. Otol., Rhin. & Laryng. **42**:692-711 (Sept.) 1933.

4. Morrison, W. W.: Diseases of the Ear, Nose and Throat, Philadelphia, W. B. Saunders Company, 1938.

5. Joseph, J.: Nasenplastik und sonstige Geschichtsplastik, Leipzig, Curt Kabitzsch, 1931.

6. Barsky, A. J.: Plastic Surgery, Philadelphia, W. B. Saunders Company, 1938.

7. Dean, L. W.: Congenital Auditory Atresia, Laryngoscope **27**:461 (June) 1917.

8. Fraser, J. S.: Maldevelopments of the Auricle, External Acoustic Meatus and Middle Ear, Arch. Otolaryng. **13**:1-6 (Jan.) 1931.

of the ear, with special reference to the abnormalities in this development which occur in cases of atresia, and illustrated his article with plastic molds and excellent drawings. Palmer and Reifsneider [9] reported a case of traumatic atresia of the external auditory canal due to an automobile accident, in which a large piece of broken glass pierced the tissues in front of the ear, dissecting the ear and a portion of the scalp behind it and destroying the cartilage and skin of the canal. They reported the successful reconstruction of the external meatus by the use of a pedicle skin graft, so arranged as to form a new lining for the canal. The procedure involved considerable dissection of the skin of the face. Hall [10] presented a single case of unilateral atresia without external deformity because of its apparent rarity. No correction was attempted. Hume and Owens [11] reported 2 cases of microtia with meatal atresia, in which they dissected all soft tissue from the bony canal to a depth approximately equal to that of the normal external auditory canal. A Thiersch graft from a hairless area of the thigh was then sutured in place over a stent mold of dental compound, and the result was said to be satisfactory. The 2 patients were followed for only three months before the cases were reported, however. Coe [12] published a brief and inconsequential paper, in which he merely mentioned some of the types of congenital deformity of the external ear. Novick [13] presented a case of circular ring atresia deep within the canal, about 1 cm. from the tympanic membrane, which, from his description, was almost certainly cicatricial in origin. He succeeded in recanalizing the tube by electrocoagulation of the cicatrix. Camp and Allen [14] presented a roentgenographic method of demonstrating the presence or absence of the external auditory canal by tomographic means in 4 cases of microtia with atresia. In all these cases no canal was demonstrable and operation was advised against. This work deserves further study as an aid to the accurate diagnosis of the condition and should prove of great help when one is deciding whether or not to operate.

As may be surmised from this survey of the literature, atresia of the external auditory canal may be congenital or acquired. More study has been devoted to the congenital type, since this presents the more complex problem and is by far the commoner.

CONGENITAL ATRESIA

Congenital atresia of the external auditory canal is almost always associated with malformations of the auricle and middle ear because of the common embryonic development of these parts. The structures of the middle and the external ear are all derived from the pharyngeal pouches. The first cleft extends laterally into the mesodermal tissues of the head, its expanded lateral end representing the future middle ear and its medial portion becoming narrowed to form the eustachian tube. At the same time, a pitlike depression appears on the external surface of the skin

9. Palmer, F. E., and Reifsneider, J. S.: Plastic Reconstruction of the External Auditory Meatus, Laryngoscope **43**:618-621 (Aug.) 1933.

10. Hall, C.: Unilateral Atresia of the Auditory Canal Without External Deformity: A Case, Ann. Otol., Rhin. & Laryng. **43**:306-309 (March) 1934.

11. Hume, J. R., and Owens, N.: Microtia with Meatal Atresia, with Description of an Operation for Its Correction: Report of Two Cases, Ann. Otol., Rhin. & Laryng. **44**:213-219 (March) 1935.

12. Coe, H. E.: Congenital Deformities of the External Ear, Northwest Med. **38**:135-136 (April) 1939.

13. Novick, J. N.: Atresia of the External Auditory Meatus, Arch. Otolaryng. **30**:744-748 (Nov.) 1939.

14. Camp, J. D., and Allen, E. P.: Microtia and Congenital Atresia of the External Auditory Canal, Am. J. Roentgenol. **43**:201-203 (Feb.) 1940.

in the region of the future auricle, and this pit extends inward for a short distance in the direction of the first gill cleft. From the inner end of this ectodermal invagination there extends inward a solid cord of ectodermal cells, which expands medially into a disklike plate, lying obliquely just outside the middle ear. This disk then becomes canalized and splits into two layers, the inner layer coming to lie against the endodermal wall of the middle ear, and separated from it only by a thin layer of mesodermal tissue, the two layers thus forming the future drum membrane. This canalization continues outward until the intervening ectodermal cell cord becomes a hollow tube and finally breaks through to become continuous with the invaginated pit on the surface. Meanwhile, the margins of the visceral clefts become thickened by an ingrowth of mesoderm between the ectodermal and the endodermal layer, and these thickenings are molded into a series of five rounded bars, known as the paired visceral arches. From the first two arches are derived the three ossicles, which at first lie outside the tympanic cavity in the mesoderm, but, by a process of expansion of the endodermal lining and invagination of the ossicles, they ultimately appear to lie within the cavity of the middle ear. Actually, they are extratympanic but are covered with endodermal membrane, entirely analogous to the intra-abdominal, but extraperitoneal, position of the small intestine. It is clear, then, that any variation in this developmental process will lead to a deformity of the external ear or of the middle ear or, more likely, of both.

The internal ear develops much earlier from an invagination of the surface ectoderm, known as the otocyst. There is no embryonic connection between this development and that of the external or the middle ear, and therefore maldevelopments of the external and middle ears are not associated with defects in the internal ear, except as a rare coincidence.

Richards [8] stated that about 1 out of every 2,000 patients seeking aid for any aural condition will exhibit a congenital atresia of the auditory canal. Our own case records, numbering about 17,000, reveal a somewhat higher incidence, especially in view of the fact that not all the patients consulted us with regard to the ears alone. The incidence of congenital atresia in our private practice, accordingly, is greater than 1 case per thousand. Cases of congenital atresia without deformity of the auricle are rare, and the condition is more often unilateral than bilateral. In spite of this, Dean [7] reported 1 case of bilateral atresia without abnormality of the auricles. Males are more often affected than females, and there seems to be some preference for the right ear.

The congenital occurrence of simple closure of the meatus by a skinlike diaphragm, though reported by Beck,[1] was disputed by Richards.[8] The presence of a normal drum membrane in any case in which operation has been performed was also denied by Richards,[8] and since the appearance of his paper no such case has been reported. Occasionally a misshapen layer of thick tissue is noted in a position analogous to that of the drum membrane, in which partial splitting of the expanded ectodermal sac has occurred. More often, in the place where one would expect to find the drum membrane there is an occluding plate of bone, which both Politzer [15] and Alexander [16] investigated embryologically and which they concluded originated from the proximal portion of the hyoid bone.

There is practically always associated maldevelopment of the os tympanum, so that there is usually no external bony meatus, or canal. Moreover, in the absence of an anterior wall of the bony canal, the temporomandibular joint develops in a more dorsal position than usual, in close proximity to the mastoid process.

15. Politzer, G., cited by Richards.[8]
16. Alexander, G., cited by Richards.[8]

In almost every case of congenital atresia the middle ear likewise presents abnormalities in development. There are frequently bands of scar tissue, and the malleus and incus, though formed, are usually fused together or otherwise abnormal. The stapes is usually normal, though it may show abnormalities of the incudostapedial joint. The eustachian tube is seldom affected. Examination of hearing in these cases shows a typical conduction loss, with slightly prolonged bone conduction and lateralization to the affected ear in the Weber test. Because of the close proximity of the facial nerve, associated paralysis or hemiatrophy of the face is occasionally seen, and other congenital deformities may occur concomitantly in the same patient.

ACQUIRED ATRESIA

Acquired stenoses of the external auditory canal vary considerably in extent and form, according to the causative pathologic processes. In general, their classification is based on whether they result from changes in soft tissue or from alterations in bone and on whether they are complete or partial.

Partial stenosis due to obstruction of soft tissue is common and usually follows chronic inflammations, such as chronic eczematoid dermatitis, repeated furunculosis and, especially, chronic suppurative otitis media. In cases of stenosis of this type there occur round cell infiltration and fibrous thickening of the dermis, with localized or diffuse narrowing of the lumen of the canal, the type of stenosis depending on the extent of the pathologic process. Occasionally the stenosis becomes almost complete, owing to associated acute edema of the epidermis, which usually subsides under medical therapy. If the condition is untreated, further narrowing of the lumen will result.

Occasionally cicatricial bands or rings are seen in the canal which are the result of the indiscriminate use of acids or the cautery or of trauma inflicted by curets or hooks used to remove cerumen. Novick [13] reported a case of this type, without knowing the cause, but suspected that the atresia was congenital. This was hardly likely. One of us (S. L. F.) has seen a case in which localized partial obstruction in a child followed repeated false paracenteses of the posterior canal wall by an inexperienced intern. A case of this kind is unusual, however.

After a radical mastoidectomy in which the plastic flaps are not properly sewn back and the granulations are not promptly dealt with partial stenosis of the canal may occur; also, after simple mastoidectomy in which the membranous wall of the canal is unnecessarily detached from the bony canal narrowing of the lumen will result unless adequate packing is employed. Ballenger and Ballenger [2] pointed out that occasionally in the aged the cartilage supporting the skin of the canal undergoes atrophic changes, which allow the walls to collapse and obstruct the canal. A soft tissue tumor of the external auditory canal, such as a benign cyst, wart, epithelioma or sarcoma, produces localized obstruction of the canal, which varies in extent according to the size of the tumor.

Complete soft tissue atresia of the canal is rare. No figures on the incidence of this condition are available in the literature, but in our own practice only 2 cases of complete atresia have occurred, representing an incidence of about 1 in 8,500 cases in which care of the ear, nose or throat is sought. The condition usually follows severe burns of the auricle and canal, either by thermal agents or by chemicals, or severe trauma to the parts, such as occurred in Palmer and Reifsneider's [9] case. Here a membrane grows over the external auditory meatus to produce complete closure. If the skin of the canal has become completely denuded, granulation tissue and fibrous connective tissue will fill the cavity of the canal. More often, only partial denudation occurs, and a mixture of granulations, fibrous tissue and

cerumen and epithelial debris is encountered at operation. If the tympanic membrane has not been injured by the original insult, and this accumulation is allowed to increase without interference, the drum membrane will ultimately suffer pressure necrosis and will perforate, when the cavity of the middle ear and the mastoid may become infected.

Osseous and cartilaginous stenoses usually take the form of benign osteoma, exostoses of the bony canal wall or chondral or perichondrial thickenings of the cartilaginous canal wall. The last condition usually follows neglected furunculosis, the lesions rupturing deep into the tissues and involving the cartilage, or results from abscess of the parotid gland or adjacent tissues breaking through the cartilaginous canal wall and draining through the external canal. Sarcoma of the bony canal wall may occur and produce obstruction, but such a growth is rare.[17]

TREATMENT OF ATRESIA

There is considerable divergence of opinion as to the necessity and advisability of treatment for congenital atresia. Furthermore, when it is decided that surgical intervention is advisable, there is still much disagreement as to the procedure of choice.

It is generally stated that the only consideration for surgical intervention in cases of congenital atresia is the status of the patient's hearing, most otologists feeling that operation is unjustifiable for cosmetic reasons alone. Of course the internal ear must be functioning before any result is possible, and the functional status may be determined by the turning tests (static labyrinth) and by tests of hearing by both air and bone conduction with the audiometer or with tuning forks. The patency of the eustachian tube should also be determined, both by nasopharyngoscopic examinations and by catheterization. (Even with a closed meatus it is possible to demonstrate the entrance of air into the middle ear by holding the auscultation tube against the obliterating membrane.) It is also pertinent to establish the presence of a middle ear by roentgenographic studies.

Beck [1] stated:

> Surgical correction is the only possibility. . . . Physiologically, there is very little to be obtained in most of these cases, that is, for hearing. However, if determined beforehand by hearing tests as well as the presence of a middle ear by roentgenograms, it may be practical to attempt to find the external auditory canal and tympanic membrane.

Richards [8] stated:

> If, in the presence of a normal labyrinth and tube, the condition is bilateral and the deafness so extensive as to be a serious handicap to the individual's activities, and particularly if speech development has been interfered with, then consideration should be given to operative efforts to improve the hearing. If the condition is unilateral, then it is a mooted question as to whether any operation should be undertaken.

Hall [10] agreed with Richards that operation should not be performed in cases of unilateral atresia except in the presence of acute mastoiditis, when a special operative technic must be employed which takes into consideration the altered anatomic relations. Ballenger and Ballenger [2] expressed strict agreement with this view, stating that "the improvement in hearing in these cases is not sufficient to justify operation."

Hume and Owens [11] disagreed with this view and expressed the opinion that in "cases of unilateral congenital microtia and meatal atresia in which there is marked

17. Mitchell, H. E.: Tumors of the External Auditory Canal, Arch. Otolaryng. **32**:831-844 (Nov.) 1940.

impairment of hearing" early operation should be carried out, as otherwise the patient is "subjected to the definite risk of nerve atrophy, and patients with impaired hearing for a long period of time develop the habit of not hearing or a complex of not registering." The authors endorsed the accepted criteria for operation (normal labyrinth; normal mastoid process as shown roentgenographically; typical conduction deafness, and patulous eustachian tube), but condemned the usually advocated surgical procedure of radical mastoidectomy as being physiologically unsound, entailing a grave risk to the patient and yielding questionable ultimate results. On the other hand, they recommended the construction of an external auditory canal in correct anatomic manner, the bony membrane usually encountered at the depth of the drum membrane being utilized as a "soundingboard" for the transmission of sound waves to the middle ear.

One of us (L. C.), in 1923, operated on a child 9 weeks of age with unilateral congenital atresia and microtia. The roentgenogram showed apparently normal development of the mastoid and internal ear on the affected side, as reported by Dr. J. W. Pierson. A simple curvilinear incision was made within the circumference of the annular ring, with the base in the concha, and all soft tissue was dissected and removed down to the depth of the tympanic membrane, where a structure was uncovered which to all outward appearances resembled the drum membrane. A stent of dental compound was inserted, and within one month the external canal was completely epithelized. The child has not been seen professionally since, but she was graduated from high school about a year ago.

It is our experience that the hearing in cases of unilateral congenital atresia is usually fairly good, even in the affected ear, so that we are of the opinion that operative intervention is seldom advisable in such cases. Furthermore, acute otitis media is exceedingly rare in these cases, perhaps because of the altered anatomic or physiologic state of the middle ear. The cosmetic results are usually not very satisfactory because of associated microtia and other maldevelopments of the auricle. Therefore, unless the hearing is unusually impaired, infection is present in the middle ear or the mastoid or the condition is unassociated with microtia and the presence of a middle ear is demonstrable roentgenographically, we do not recommend operation in cases of unilateral atresia. In cases of bilateral congenital atresia operation is usually indicated because of the rather serious impairment of hearing and the handicap this will be to the patient. In such cases operation should be done at an early age, even before the third month of life.

With the acquired (traumatic) type of complete atresia, there is little doubt as to the advisability of operation. First, the presence of a middle ear is assured by the history. Second, an ear with this type of atresia is equally as vulnerable to infections of the middle ear as is the normal ear, and such a complication would seriously endanger the patient. Again, the success of the operative treatment is assured, both from the standpoint of the restoration of hearing and the excellence of the cosmetic result, if good surgical principles are adopted.

It is our conviction that extensive surgical repair is not necessary to restore the normal anatomic and physiologic condition in most cases of acquired atresia. The fancy incisions, extensive dissections and complicated pedicle grafts or Thiersch grafts from the thigh applied by means of stent molds are not essential and usually merely serve to complicate the operation. We employ a simple plastic operation, illustrated by the following case.

W. B., a Negro aged 60, was first seen by one of us (S. L. F.) in the dispensary of the Baltimore Eye, Ear and Throat Charity Hospital on Jan. 3, 1942. He complained of deafness following a chemical burn of the left side of the face and the left ear about five months before.

Fig. 1.—Photograph of the patient's ear before operation, showing complete atresia by an occluding skin membrane. (Candid camera used at 3 feet [90 cm.].)

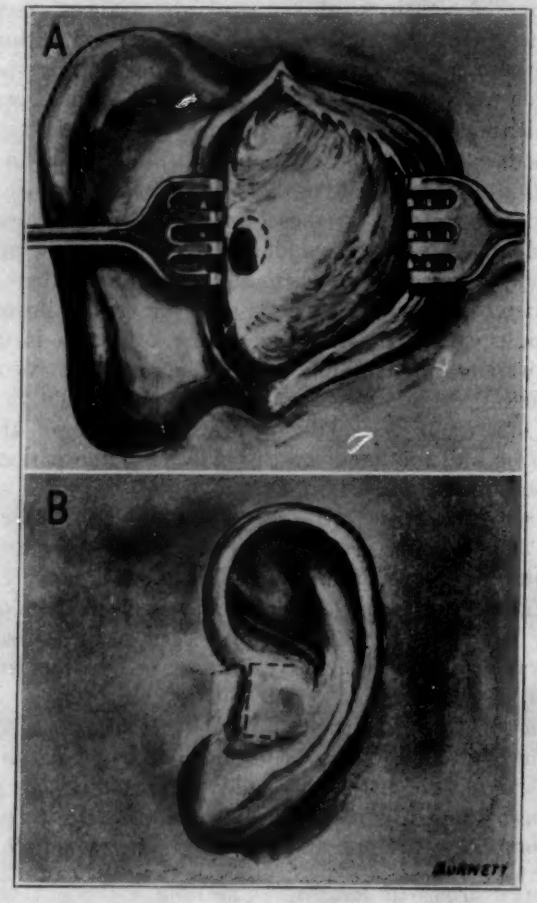

Fig. 2.—(*A*) The dotted line shows how the posterosuperior canal wall is taken down with the electric burr to enlarge the bony canal. (*B*) The dotted lines show the manner of making the flap from the occluding skin membrane to line the new canal.

During a quarrel, his wife, who was in close proximity to him, threw a can full of lye at him, and he suffered severe burns of the face, ear and chest on the left side. He was treated in the accident room of another hospital and was followed in the surgical dispensary of the same hospital for two months and was then discharged. When he returned with the complaint of increasing difficulty in hearing, he was referred to this dispensary. Examination at this time showed complete closure of the external auditory meatus by a skinlike membrane, which stretched from the tragus across the concha (fig. 1). There were several areas of depigmented skin about the auricle and face, evidence of second degree burns. The membrane was firm, tough, but pliable, and smooth. It resembled skin in every respect and, indeed, was

Fig. 3.—Photograph of the patient's ear ten months later. (Professional camera used at 10 inches [25.4 cm.].)

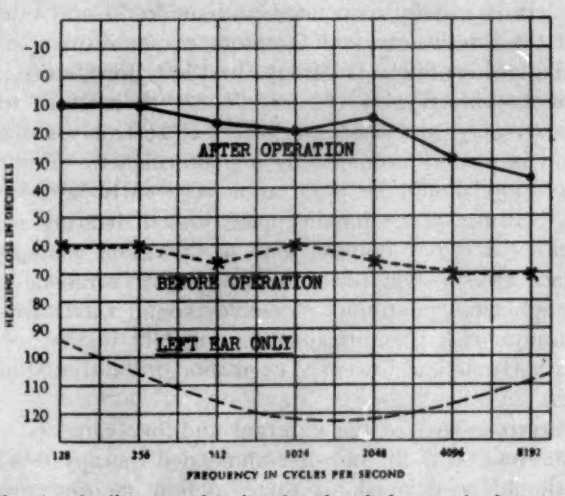

Fig. 4.—Audiogram showing hearing before and after operation

accepted as such. There was pronounced loss of hearing of the conduction type (fig. 4), with apparently increased bone conductivity (negative Rinne test), lateralization of sound to the affected side in the Weber test, a patulous eustachian tube and a normal middle ear and bony external canal on roentgenographic examination. The patient complained, also, of increasing discomfort in the ear, described as a sensation of pressure, so that operation was advised.

On January 8, with the patient under ether anesthesia, the usual postauricular incision was made over the mastoid close to the auricular attachment, the incision being carried down to the bone. The periosteum and the soft tissues were elevated from the bone and retracted. The bony external auditory canal was uncovered by freeing the cartilaginous canal from it, when the bony canal was noted to be filled with a large collection of cerumen, desquamated epi-

thelium and debris. This accumulated debris exuded under pressure as soon as the cartilaginous canal was freed at its attachment to the bony canal. The drum membrane was located and observed to be intact, though badly macerated. With the electric burr, the posterosuperior wall of the canal was taken down for about 3 mm. along its entire length, care being taken not to get into the cellular portion of the bone (fig. 2*A*). This enlarged the bony canal by about one third and thus insured against cicatricial stenosis afterward. The auricle was now replaced in its normal position, and the edges of the postauricular incision were held apposed in order to survey the landmarks. A modified Stacke flap was then made from the posterior margin of the tragus to the posteriormost edge of the concha, directly over the newly enlarged external meatus (fig. 2*B*). The cartilage in this flap was trimmed with the knife to make the flap more pliable and less rigid, and the flap was turned back into the new bony canal and held in place with iodoform gauze packing. The postauricular incision was now closed with fine catgut for the periosteum and subcutaneous tissues and with black silk for the skin. The usual mastoid dressing was applied. The packing was left undisturbed for seven days, when it was carefully removed and the wound cleaned with alcohol and repacked with iodoform gauze. At the end of fourteen days, when the packing was removed, the wound was observed to be almost entirely epithelized, with only an occasional granulation to be burned down with silver nitrate. Light packing was maintained in the canal for three more weeks, a total of five weeks. At the end of this time the canal was completely healed; there was no evidence of cicatricial contraction or stenosis, and the patient's hearing was practically normal. The drum membrane had regained much of its color but still appeared somewhat dull, thickened and macerated. All treatment was discontinued except the daily application by the patient of a small amount of ammoniated mercury ointment (3 per cent ammoniated mercury in petrolatum U. S. P.) to keep the skin of the canal moist and to prevent scaling. Figure 1 shows the appearance of the ear the day prior to operation; figure 2, the two essential stages in the operation, and figure 3, the ear ten months after the operation. Figure 4 presents the audiograms before and after the operation.

SUMMARY AND CONCLUSIONS

Congenital atresia of the external auditory canal occurs more frequently than is generally supposed. It is usually associated with microtia and other deformities of the external and the middle ear and therefore presents many problems in its correction. The unilateral condition is perhaps best left alone, since in cases of this deformity it is rare for infection of the middle ear or mastoid to develop, the hearing is usually fairly good and operation offers at best only moderate improvement in hearing, and is usually attended by a poor cosmetic result. In cases of bilateral atresia operation should be done at a very early age, even before the third month of life, because of the handicapping loss of hearing which is always present. In such cases it is our opinion that an operation analogous to the one described for traumatic atresia should be done, rather than a radical mastoidectomy, as the latter is an unphysiologic attempt to convey sound waves to the middle ear and is attended by more risk than its uncertain results justify. In this respect we agree entirely with Hume and Owens,[11] even though we should adopt a simpler operative procedure.

Acquired atresia (complete) of the external auditory canal is rare. When it occurs, operative intervention is the only recommended therapy. Whenever possible, the operation should be delayed for three to four months after the original trauma, in order to permit the cicatricial occluding membrane to become toughened and therefore available for use as a skin flap in the plastic procedure advocated. Otherwise, it will be necessary to make use of a tubular Thiersch graft obtained from a hairless area of the thigh and applied over a stent mold. The results, both as to the restoration of hearing and the cosmetic appearance, are good if sound surgical principles are followed.

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USE OF CURARE TO FACILITATE ENDOSCOPY

A PRELIMINARY REPORT

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On occasions, fortunately infrequent, every endoscopist has had the trying and often traumatic experience of being unable to obtain sufficient cooperation from a patient to permit satisfactory endoscopy. This lack of cooperation may be manifested by either an unwillingness or an inability to relax the jaw, to keep the tongue and epiglottis quiet, to relax the neck and to keep the pharynx quiet. In such persons the cricopharyngeus muscle is often in a spastic state.

Many endoscopists have attempted to circumvent the aforementioned obstructions to a completely satisfactory examination by employing general anesthesia. Anesthesia has been produced with tribromethanol in amylene hydrate, given by rectum; with pentothal sodium (the monosodium salt of 5-ethyl-5-[1-methylbutyl] thiobarbituric acid) or evipal sodium (sodium N-methyl-cyclohexenyl-methyl barbiturate), injected intravenously, and with various inhalation agents. Although endoscopic procedures can be performed with the patient anesthetized by any of these methods, there are a few significant disadvantages to the practice. The endoscopist loses the voluntary cooperation of the patient, which is of value in many procedures. The nature of the procedure frequently results in direct or reflex stimulation of laryngospasm causing obstruction of the patient's airway, with consequent hazard to the patient. Deep anesthesia is usually required. This causes prolonged recovery, which seems unjustified for a relatively short and simple diagnostic or therepeutic procedure.

An extract of curare [1] is being used in conjunction with inhalation anesthesia to produce muscular relaxation.[2] Relaxation of extreme degrees can be obtained with relatively little and short respiratory depression and inappreciable cardiac or vasomotor depression. The action of curare is somewhat selective. The muscles of the head and neck are relaxed before paralysis of respiratory muscles and of muscles of the extremities develops. It therefore seemed feasible to use the drug to obtain relaxation for endoscopy without producing respiratory depression or paralysis. Curare has no analgesic property, so it is necessary to anesthetize the patient's pharynx and larynx with cocaine or a similar drug. With this combination, the cooperation of the patient is retained, the incidence of laryngospasm or other obstruction of the airway is minimized, and recovery is prompt, with no unpleasant postanesthetic sequelae.

The drug is supplied as an extract containing the equivalent of 20 mg. per cubic centimeter of a standard extract. It is administered without dilution, intra-

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1. The extract of curare used for the patients included in this report was supplied by E. R. Squibb & Sons, New York, and is marketed under the name intocostrin.

2. Cullen, S. C.: The Use of Curare for the Improvement of Abdominal Muscular Relaxation During Inhalation Anesthesia, Surgery **14**:261-267 (Aug.) 1943.

venously or intramuscularly. It is ineffective by subcutaneous or peroral routes. The peak of action is obtained in two minutes when the drug is administered intravenously and in fifteen minutes when it is administered intramuscularly. Overdosage causes paralysis of the respiratory muscles, which is most effectively combated by giving artificial respiration with oxygen. This is most conveniently done by applying an anesthetic face mask to which is attached an oxygen supply and a rebreathing bag. Manual compression of the rebreathing bag effects efficient ventilation when there is a clear airway. Prostigmine methylsulfate is also an effective antidote. It is mandatory that the means for artificial respiration and a person capable of using them be immediately available in the event miscalculation of dose results in extreme respiratory depression.

Observations on Effects of Curare

No.	Name	Age	Sex	Procedure	Initial Dose, Mg.*	Additional Dose, Mg.*	Total Dose, Mg.	Relaxation	Respiratory Effect	Circulatory Effect
1	G. T.	2	M	Esophageal dilatation	10 IM	10 IM	20	Good	Intercostal paresis	None
1	G. T.	2	M	Esophageal dilatation	15 IM	5 IM	20	Good	Intercostal paresis	None
1	G. T.	2	M	Esophageal dilatation	30 IM	0	30	Good	Intercostal paresis	None
1	G. T.	2	M	Esophageal dilatation	30 IM	0	30	Good	Intercostal paresis	None
1	G. T.	2	M	Esophageal dilatation	25 IM	0	25	Good	None	None
1	G. T.	2	M	Esophageal dilatation	30 IM	0	30	Good	Intercostal paresis	None
1	G. T.	2	M	Esophageal dilatation	25 IM	0	25	Good	None	None
1	G. T.	2	M	Esophageal dilatation	30 IM	15 IV	45	Good	Intercostal paresis	None
2	L. V.	4	F	Esophagoscopy	20 IM	0	20	Good	None	None
2	L. V.	4	F	Esophagoscopy	30 IM	0	30	Good	None	None
3	R. A.	13	F	Lynch suspension	50 IV	0	50	Good	Respiratory paresis 2 minutes	None
3	R. A.	13	F	Lynch suspension	35 IV	20 IV	55	Good	Laryngospasm	None
3	R. A.	13	F	Lynch suspension	45 IV	0	45	Good	Laryngospasm	None
4	H. A.	40	M	Lynch suspension	60 IV	40 IV	100	Fair	Intercostal paresis, laryngospasm	None
4	H. A.	40	M	Lynch suspension	60 IV	40 IV	100	Good	Slight laryngospasm	None
5	W. W.	13	M	Bronchoscopy	50 IV	0	50	Good	Intercostal paresis	None
5	W. W.	13	M	Bronchoscopy	35 IV	0	35	Good	None	None
6	D. O.	9	F	Lynch suspension	25 IV	20 IV	45	Good	None	None
6	D. O.	9	F	Lynch suspension	45 IV	0	45	Good	None	None
7	O. D.	61	M	Lynch suspension	50 IV	0	50	Good	None	None
8	N. M.	6	M	Lynch suspension	30 IV	0	30	Good	None	None
9	S. G.	88	M	Esophagoscopy	40 IV	15 IV	55	Good	None	None
10	M. F.	21	F	Esophagoscopy	50 IV	0	50	Good	None	None
11	S. S.	66	F	Lynch suspension	40 IV	0	40	Good	None	None
12	A. L.	3	F	Esophagoscopy	30 IM	0	30	Good	Respiratory arrest 3 minutes	None
13	W. B.	33	M	Lynch suspension	50 IV	0	50	Good	None	None
14	L. R.	61	F	Lynch suspension	40 IV	30 IV	70	Good	None	None
15	J. H.	75	M	Esophagoscopy	20 IV	20 IV	40	Good	None	None
16	C. W.	56	M	Lynch suspension	70 IV	0	70	Good	None	None

* IM, intramuscular; IV, intravenous.

The extract of curare was given to 16 patients for 29 procedures. The accompanying table lists the details. The patients were premedicated with barbiturates by mouth, with morphine and with scopolamine. The subcutaneous or intravenous injection of a salt of scopolamine or of atropine is essential premedication for the use of curare because it blocks the muscarinic action of that drug. Without scopolamine or atropine, excess salivation develops and respiratory depression and paralysis appear with the smaller doses of curare. A 10 to 20 per cent solution of cocaine hydrochloride was applied topically for analgesia of the pharynx and larynx. With this medication the patients were at ease yet sufficiently orientated to permit full cooperation for endoscopy. The extract of curare was usually administered intravenously just before the endoscopic procedure was to be started. If the drug was injected intramuscularly, it was given fifteen minutes prior to the start of the endoscopic manipulations. The intravenous route was preferred because of the prompt onset of action, which permitted better estimation of the effect and

allowed quicker addition of drug if more was needed. Enough curare was given to prevent the patient's lifting his head off the table when in the supine position. In children this usually required 20 to 40 mg., and in adults, 50 to 60 mg. With the curare effective, the neck was relaxed, the jaw was loose, the tongue and pharynx were quiet and the cricopharyngeus muscle offered little or no opposition to the introduction of an esophagoscope. The drug effect usually lasted about twenty to thirty minutes. The patients were returned to their beds without supervision and allowed to eat or drink as much as was permitted following endoscopy.

As can be seen from the table, complete respiratory paralysis developed in 2 patients; it lasted two to three minutes. This was due to our inexperience in estimating the dose required. The paralysis was easily controlled by artificial respiration, and the endoscopic examination was completed without restrictions. Others had definite paresis of intercostal muscles, but this was not sufficient to embarrass pulmonary ventilation. In 3 patients laryngospasm was precipitated by the manipulation. The latter complication can be minimized by more complete anesthetization of the larynx and vocal chords. Eight of these patients had had endoscopic manipulations on previous occasions which were unsatisfactory. The use of curare permitted easy, nontraumatic and complete examination.

Patient 9 was examined for a possible foreign body by means of the esophagoscope. His deafness, lack of understanding of English and senile changes made cooperation impossible in spite of premedication and topical anesthesia. The muscular relaxation following the administration of curare permitted the procedure to be done easily, quickly and without any danger of serious trauma from wild, uncontrolled actions. Patient 15 represented a somewhat similar problem. Because of senile psychotic changes he became uncooperative and unruly at the time of the procedure. After the injection of 40 mg. of curare, the wild movements of the head, neck and shoulders ceased, and an impacted lower dental plate was easily removed from the upper part of the esophagus.

Many of the patients reported on here had the glottis exposed by means of the Lynch suspension apparatus. Even in the most cooperative patient there is appreciable resistance to the traction exerted by this apparatus. Curare permitted quicker, more comfortable, more complete and more permanent exposure.

It will be noted from the table that many of the patients were children. One of the youngsters, patient 3, had multiple laryngeal papilloma which necessitated frequent removal. She had been anesthetized with ether on previous occasions. She professed a preference for the curare–topical anesthesia combination. It is entirely possible that in a surprising number of children there will be less mental and physical stress with this combination than with general anesthesia, however the latter may be induced or maintained.

It is well recognized that most endoscopic work can be accomplished under topical anesthesia if the patient is well premedicated. It is our feeling that curare should be used as an aid only with those patients who are difficult. From our preliminary observations we feel that it possesses advantages over general anesthesia in this type of diagnostic or therapeutic manipulation.

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PERCUSSION NOTE OF THE MAXILLARY SINUS

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The introduction of a problem of physical diagnosis to otolaryngologists may seem like turning back a number of pages in the history of medicine. In reality, the urge to present this subject comes from a realization that much of the art of medicine is being lost with the development of other diagnostic methods. Younger practitioners are reported to be deficient in physical diagnosis by chiefs of tuberculosis sanatoriums. Graduate students in otolaryngology are entering the specialty with less of the background of general medicine than formerly. The time of the otolaryngologist is so limited in studying his patients that short cuts are used and the opinions of others are too often taken at face value. Except by a comparative few, practitioners in internal medicine, the art of physical diagnosis is being neglected, and its loss is not fully compensated for by the substituted methods.

Of the classic methods of physical diagnosis, inspection, palpation, percussion and auscultation, only those depending on the senses of sight and touch have persisted up to the present time in the literature on the diagnosis of disease of the maxillary sinus. Auscultation, used to detect the "succussion splash," was one of the early methods of value because disease of the maxillary sinus was suspected only when abscess existed. Since the recognition of early, and less discernible, pathologic conditions of the antrum, auscultation has rarely been used.

Percussion, a method dependent also on the sense of hearing, has no doubt been employed in connection with disease of the maxillary sinus almost since Corvisart, in 1808, made Auenbrugger's discovery popular. Most otolaryngologists use it to some extent today, but it is of interest to note that little reference is made to this method in the literature, even during the nineteenth century, when detection of physical signs represented the maximum in the physician's art of diagnosis. This may have been due to the imperfect knowledge of sinus disease at that time, the almost invariable association of apical infection of teeth with disease of the maxillary sinus and the rather universal use of percussion to elicit dulness over an abscessed maxillary sinus. In the several editions of Bosworth's [1] fairly complete text, percussion of the antrum is spoken of as follows:

> Percussion of the two sides should always be resorted to, for by this means we may detect dullness over the affected side as well as a certain amount of sensitiveness.

It is natural that since the introduction and improvement of sinus roentgenology in the early part of the twentieth century, dependence on physical signs should be less popular in doubtful cases of disease of the maxillary sinus. Nevertheless, with such a routine procedure as percussion ready at hand, would one not be remiss in discarding a developed art for dependence on other means, less accessible and still subject to error?

Just as without the special senses no diagnosis would be possible, so with them it would seem ridiculous to say that only "seeing is believing." It is an important

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Submitted as a candidate's thesis for admission to membership in the American Laryngological, Rhinological and Otological Society, Inc., 1943.

1. Bosworth, F. H.: A Textbook of Diseases of the Nose and Throat, ed. 2, New York, W. Wood & Co., 1896.

purpose of this thesis to serve as a reminder that the organ of hearing can be relied on. The ear is known to be one of the most carefully guarded of the special sense organs. Its evidence is far more truthful at times than that of the organ of sight. In speech, for example, inflection, accentuation and little eccentricities mean much more than the written words. The memory for auditory impressions is much more lasting than visual ones. In narcosis hearing is the last to disappear. The science of sound, which had its beginning with Pythagoras, about 550 B. C., has intrigued and baffled such investigators as Aristotle, Euclid, Ptolemy, Francis Bacon, Galileo, Robert Boyle, Isaac Newton and physicists of the present day. It was Lord Bacon who said, in the seventh century:

> The nature of sounds hath in some sort been inquired as far as concerneth music, but the nature of sound in general hath been superficially observed. It is one of the subtlest pieces of nature.

No instrument of precision has yet been devised to indicate the quality of sound as accurately and easily as does the ear. In the motion picture "Fantasia" an effort is made to visualize the quality of sound produced by various orchestral instruments. Oscillographic vibrations of the bass drum contrast sharply with those of the trumpet and the woodwinds, but the ear can detect many more characteristic differences, which one calls the qualities of sound.

Leopold Auenbrugger, born in Grätz, Austria, published his "Inventum Novum" in 1761. In this work he announced that percussion sounds are simply manifestations of acoustic phenomena and that variations in these sounds are due to the physical variations of the tissues percussed. This principle is the basis, then, for the assertion here that the percussion note of the maxillary sinus in a young, healthy adult is tympanitic. To produce a tympanitic note from a cavity, the cavity must be of sufficient size that the contained air can be set into vibrations which are in unison and rhythmic. It must be sufficiently superficial or be accessible to activation of its air content by the percussion stroke. Part or all of its walls must be membranous or flexible, so that reflected vibrations from other, less flexible, walls will not interfere with the fundamental rhythmic vibrations.

The maxillary sinus is such a cavity. If its walls were composed throughout of unyielding bone, it is unlikely that a true tympanitic note could be produced. But the nasoantral partition is in a great measure flexible and has perforations, or ostiums, so that reflected vibrations from the bony walls can escape and are not multiplied indefinitely. Another essential present in the maxillary sinus for the production of tympany is proper air tension or lack of pneumatic hypertension. The ostiums and the flexible nasoantral wall are responsible for this also. Under normal conditions the ostiums allow quick and free adjustment of air pressure between the sinus and the outside air. The experiment in which the flaccid cheek is percussed, in contrast to the puffed cheek, where air is under pressure, is a good example. The greater the air pressure the higher will be the pitch of the sound produced.

The most characteristic tympanitic note obtained from the maxillary sinus is noted in older persons with large, clear sinuses and atrophy of the nasal and sinal mucous membranes. In these persons the volume of air in the sinus is large; the air tension is low, and the walls of the sinus are comparatively thin and superficial. Percussion is easy because of the absence of much overlying soft tissue to deaden the stroke, and there is less chance for diffusion through an otherwise thick and cancellous bone.

Experts in methods of physical diagnosis claim that in order best to produce a tympanitic note the pleximeter should be applied lightly, but closely, to the wall

of the cavity and the stroke of the plexor should be made slowly and in a manner to penetrate. In this way the whole volume of air in the cavity is simultaneously set in vibration. A short, sharp or staccato stroke is more likely to set a small part of the air into vibration and even to activate other small areas of the wall at distant places independently and asynchronously.

In a practical method which is recommended, the distal phalangeal joint of the left middle finger is placed firmly into the canine fossa outside of the cheek. The soft tissue of this locality is compressed and to some extent displaced. Moderate pressure is exerted away from the alveolus and toward the face of the maxillary bone. With the middle finger of the right hand as plexor, a slow, but decided, blow is struck on the joint of the left middle finger, care being taken to direct the blow in the line of pressure and away from the alveolus. The two sides of the maxilla are compared in this fashion. As in percussion of the chest or a viscus, it is best to regulate the force of the percussion stroke according to the depth and resistance of the wall through which the impulse must travel, and not to use any greater force than is necessary to activate the whole content of air in the sinus. The room should be reasonably quiet. False teeth or dentures should be removed. The patient's head should not rest on a pillow or head rest without allowance being made for the tone quality of these structures. The mouth should be closed, unless comparison is to be made with the tympany of the mouth cavity by alternately percussing the alveolus.

Artificial plexors and pleximeters have been tried, but in most instances they were unsatisfactory because the pleximeter often did not fit the canine fossa and its artificial composition contributed tonal qualities quite different from those of the bone of the sinus wall. Direct, or immediate, percussion may be satisfactorily employed in a few instances by striking the malar prominence with the plexor finger without any pleximeter being interposed. This method may be used when the sinus is large, its walls are thin and there is a minimal amount of superficial fat or soft tissue. The chief reason that direct percussion is not satisfactory with the antrum is that the force of the percussion stroke is disseminated through the denser portions of the malar bone and zygomatic arch, away from the sinus, and sets up conflicting overtones in various areas at some distance from the sinus. There is no doubt that an appreciation of density may be had by direct percussion, and this of itself is valuable. With mediate, or indirect, percussion in the canine fossa, as outlined, the thinness of the wall at this point assures one the greatest opportunity of setting the whole volume of air into rhythmic vibration, and while this is being done a sense of density is also appreciated. Because the bone of the fingers has a tone quality somewhat similar to that of the bone of the maxilla, a purer note is produced and is conducted through the examiner's bony framework, as well as through the air, to his ear. Patients with good tone perception are often the chief ones to acknowledge the quality of the note and its difference in the two maxillary sinuses. Observers and students often must percuss the sinus themselves to appreciate its tone quality. Demonstration by another is not so clear.

Departures from normal of the maxillary sinus, either in the structure of its walls or in its contents, influence the quality and the pitch of the percussion note. The thicker the walls the higher the pitch and the duller the quality of the note. The presence of liquid or soft tissue, such as polyps, filling the sinus, likewise increases the pitch and alters the quality, until an absolute flatness is obtained. This may be demonstrated in the course of the usual irrigation of the maxillary sinus and should indicate the relative amount of air remaining. Tympany, dulness and numerous degrees of each may be recognized and will aid in differentiation of the condition of one maxillary sinus from that of its fellow on

the opposite side. In the case of a departure from normal one is interested in knowing whether air is present in the sinus and, if present, to what degree the pathologic process or abnormality interferes with its detection. In general, the quality of the percussion note indicates the amount of air in the sinus, and impairment of the note, the degree of abnormality or pathologic change.

No one would state that the volume of air in a sinus must reach a stated amount to be normal, for normal sinuses vary greatly in size. Some authors are content to say that the sinus cavity of a young, normal adult should be about the size of a walnut. It might be just as correct to say that it should be of sufficient size to produce a tympanitic note. Most middle-aged persons who have lived in climates conducive to catarrh, or who have had repeated head colds or attacks of sinusitis show changes in the mucous membrane, and even in the bone, which thicken the walls of the sinuses and impair the percussion note. True tympany is often obtained, however, in these persons, but most often the impairment is so pronounced that the quality of the note is no longer tympanitic but dull. One may suspect, therefore, that the amount of air is diminished or the walls are thickened or the composition of the wall, such as the density of the bone or the elasticity of the nasoantral partition or any combination of these two factors, is changed.

Most otolaryngologists have encountered cases in which transillumination showed a clear sinus and yet washings of the sinus yielded a collection of pus, as well as cases in which sinuses which were relatively clear on transillumination yielded cystic fluid or mucous polyps when they were opened. In such instances the percussion note is of great value, because invariably it is at variance with the results of transillumination. Cases are more numerous, however, in which thick bony development makes transillumination of no value because of dense shadows and yet the percussion note is tympanitic, indicating a normal content of air. In cases of chronic disease of the maxillary sinus of recurring nature or of long standing, dulness on percussion invariably corresponds with the presence of shadowing on transillumination. A deviated nasal septum, which is frequently accompanied by shadowing of the maxillary sinus on the side of the deviation, may not be associated with any other sign of sinus disease. The percussion note in a case of this kind is apt to be tympanitic, suggesting a normal volume of air.

During the progress of the disease in a maxillary sinus the percussion note changes from time to time, and it frequently resumes the tympanitic quality when recovery has been established. Persistence of dulness or impaired tympany after acute inflammation of the sinus must be considered, however, in relation to the note obtained before the acute attack began. It has been observed that the presence of polyps in a maxillary sinus will cause greater impairment of the percussion note if the growths are related to the nasoantral partition. A nostril full of polyps which obstruct the maxillary ostiums and interfere with the elasticity of the nasoantral partition will likewise impair the percussion note and will most often make it dull, rather than in any degree tympanitic. It is presumed that in many cases of such lesions changes have occurred in the mucous membrane of the sinus which impair the percussion note, but this is not necessarily so. In cases of allergy, with acute blocking of one or both nostrils, the percussion note over the maxillary sinus of the blocked side is impaired or dull as compared with the note before the acute paroxysm began. If sufficient shrinking is possible to remove the acute blocking and the sinus is clear, a tympanitic note can again be obtained.

It is conceivable that with modification and perfection of the technic of percussing the maxillary sinus the examiner may learn much about the size of the sinus, the degree and kind of the pathologic process present and, to some

extent, the location of such a lesion in the sinus. Percussion of the maxillary sinus in conjunction with roentgenographic examination, transillumination and irrigation will help to remedy some of the deficiencies of the last-mentioned means of diagnosis and will give a better understanding of the abnormal state of the sinus. It must not be inferred that the percussion note is thought of as infallible. It is not my intention to say that it is even superior to transillumination or any other means of detection of a pathologic process in the maxillary sinus. The procedure is suggested as a diagnostic method worth using to substantiate or cast doubt on the value of other methods of examination, which of themselves are fallible.

Oscillographic tracings of the sounds involved failed to show much that was reliable. Methods of amplification, however, were employed in the laboratory with some success. A small receiver of a sonatone set was used and was most effective when placed in the nasal vestibule on the side of the maxillary sinus to be percussed. When the receiver was placed on the maxillary bone of the same side or in the nasal vestibule of the opposite side, the note was not nearly so clear.

Percussion is an art which every physician has learned and in which many have allowed themselves to become rusty. Percussion must be thought of not as just another method of examination of the antrum but as a means which calls on another mechanism of perception and makes use of sound, that unfathomable stimulus which as yet the organ of hearing alone can analyze. Let this paper carry an appeal to all to use their ears and their hands, as well as their eyes, in the physical diagnosis of disease of the maxillary sinus. The information gained through the use of many senses will certainly improve the appreciation of that obtained through the use of each alone.

SUMMARY

Percussion, in contradistinction to other means of examination of the maxillary sinus, depends on the use of the organ of hearing, with sound as the stimulus.

Since Corvisart made Auenbrugger's discovery of percussion popular, in 1808, there has been little reference in the literature to its use in diagnosis of disease of the maxillary sinus.

The normal maxillary sinus of an adult satisfies the understood structural requirements for the production of a tympanitic note by percussion.

A method of percussion of the maxillary sinus is suggested.

The quality of the percussion note indicates the amount of air in the sinus, and impairment of the note, the degree of abnormality or pathologic change present.

Percussion often produces results at variance with those of other means of examination of the maxillary sinus.

As a readily available means, percussion is useful in determining the progress in a case of disease of the maxillary sinus.

Percussion of the maxillary sinus is not thought of as infallible but is suggested as a diagnostic procedure worth using to substantiate or to cast doubt on the value of other means, which of themselves are fallible.

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EFFECT OF THE EXTRINSIC LARYNGEAL MUSCLES ON VOICE PRODUCTION

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Knowledge of the effect of the musculature of the larynx on voice production is meager. Information is available on the action of a large number of individual muscles, but one is as yet far from being able to explain all movements of the larynx on the basis of the action of these muscles. However, the synergic reactions of the larynx must in most instances depend on the activity of the individual muscles involved.

Information on the physiology of the intrinsic laryngeal muscles is much more adequate than that on the extrinsic muscles. Thus, the vocal result of any defect due to impairment of an individual intrinsic laryngeal muscle, or of a group of them, is rather well known. The function of the extrinsic laryngeal muscles in voice production is, however, not clear. The few contributions to the subject have differed, and have even been contradictory, in their conclusions. This is evident from a study of the literature in question.

Weiss [1] distinguished between two groups of extrinsic laryngeal muscles: The one moves the larynx as a whole and the other the individual parts of the larynx in relation to each other. A description of the first set of muscles provides a foundation for an understanding of the problem and serves as a background for a review of opinions expressed by other authors, such as Eykman,[2] Scheier,[3] Küpferle,[4] Mink [5] and Elze,[6] from whose work the two diagrams included here are taken.

The movements of the larynx as a whole are possible because the larynx is anatomically placed, so to speak, in a slideway of loose connective tissue (fig. 1). Anteriorly, this slideway is bounded by skin, with the underlying bursa subcutanea, over which slips the anterior part of the larynx, especially in a vertical axis. Posteriorly, the slideway is bounded by the fascia colli profunda and the spinal column, and laterally, by muscle. Within this slideway active movements of the larynx are possible upward and downward and in the anteroposterior axis. On the other hand, only passive lateral movements are possible.

Moreover, the larynx passively follows the movements of the hyoid bone, for the two are connected by the thyrohyoid membrane and the thyrohyoid muscle. The position of the hyoid bone itself is changed by the muscles attached to it: the geniohyoid, the mylohyoid and the anterior belly of the digastric muscle (fig. 2).

From the Speech Department of Capital University.

1. Weiss, O., in Bethe, A., and others: Handbuch der normalen und pathologischen Physiologie mit Berücksichtigung der experimentellen Pharmakologie, Berlin, Julius Springer, 1931.

2. Eykman, P. H.: Arch. f. d. ges. Physiol. **99**:513, 1903.

3. Scheier, M.: Arch. f. Laryng. u. Rhin. **22**:175, 1909; Fortschr. a. d. Geb. d. Röntgenstrahlen **18**:377, 1911-1912.

4. Küpferle, L.: Arch. f. d. ges. Physiol. **152**:579, 1913.

5. Mink, P. J.: Physiologie der oberen Luftwege, Leipzig, F. C. W. Vogel, 1920.

6. Elze, in Denker, A., and Kahler, O.: Handbuch der Hals-Nasen-Ohren-heilkunde, Berlin, Julius Springer, 1925, vol. 1, p. 240.

These muscles draw the hyoid bone anteriorly and cephalad. The cephalad element of movement depends on the position of the chin. The higher the chin is raised the greater the cephalad movement and vice versa. The hyoid bone is pulled posteriorly and cephalad by the posterior belly of the digastric muscle and the stylohyoid muscle. It will be seen from figure 2 that the muscles which pull the larynx anteriorly and those which pull it posteriorly are antagonists while the muscles which produce the cephalad movements are synergists. How far the cephalad elements come into action depends on the position of the chin. Thus, it may be supposed that the larynx, because of its connective tissue and muscle connections with the hyoid bone, moves in concerted action with and because of the movements of the hyoid bone.

Movement of the larynx is also aided by the thyrohyoid muscle, which acts by raising the larynx and moving it anteriorly, and by the stylopharyngeal and the palatopharyngeal muscle, the laryngeal portion of which raises the larynx and

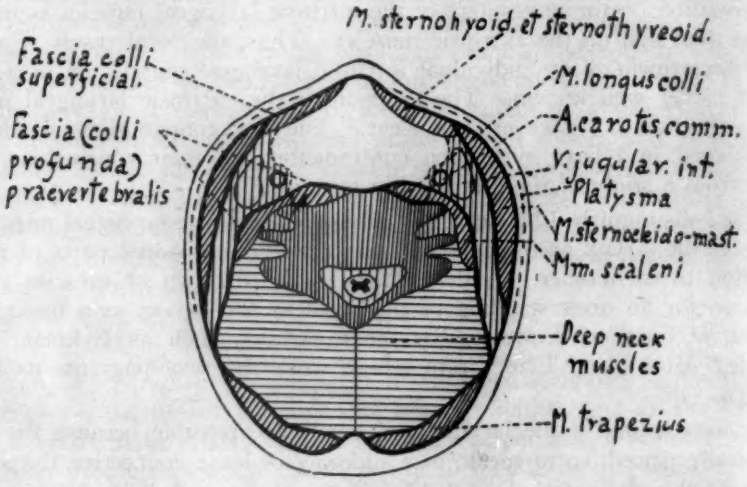

Fig. 1.—Relation of the larynx to surrounding structures (slideway).

moves it posteriorly. Of less importance is the action of the obliquely ascending fibers of the laryngopharyngeus (constrictor pharyngis inferior) muscle.

These muscular mechanisms also fix the larynx in a cephalic direction. The antagonists of these muscles are the omohyoid and the sternothyroid. The tracheal tug, according to Mink,[5] indicates that the elasticity of the connective tissue acts in the same way. The net result of the actions of the muscles, plus the elasticity of the connective tissue, is to keep the larynx fixed in any position in which it can anatomically be placed.

In the literature concerned with the actions of the extrinsic laryngeal muscles on the movements of the individual parts of the larynx with relation to each other, discussion has dealt mainly with the following muscles: the sternothyroid, the thyrohyoid, the sternohyoid, the laryngopharyngeal and the omohyoid. The actions of these muscles are of interest from their effect on the movements of the vocal cords and on voice production.

Merkel (1857 and 1863)[7] emphasized that the sternothyroid muscle moves the thyroid cartilage around a horizontal axis passing through the cricothyroid

7. Merkel, C. L.: Anatomie und Physiologie des menschlichen Stimm- und Sprach-Organs (Antropophonik), Leipzig, A. Abel, 1857 and 1863.

joint. At first he expressed agreement with the view of older authors, such as D'Espine, that the movement in question consists of rotation on the axis ("tilting") anteriorly and lengthening and stretching of the vocal cords, so that the pitch is raised. In this action the sternothyroid muscle is supported by the thyrohyoid muscle. Later, Merkel, on the basis of ingenious theoretic con-

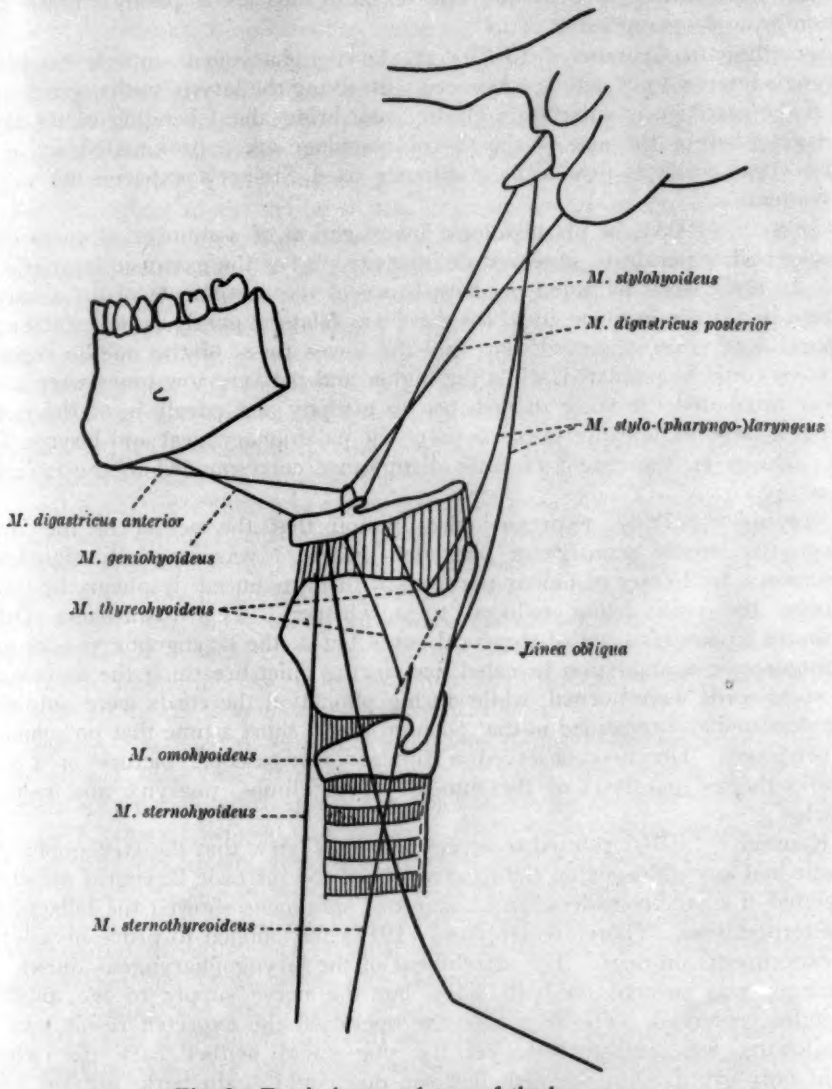

Fig. 2.—Extrinsic musculature of the larynx.

siderations, came to an opposite conclusion, namely, that both muscles rotate the thyroid cartilage posteriorly and that with this movement there occur a shortening and relaxation of the vocal cords, which lower the pitch.

On the other hand, Vierordt[8] (1877) showed experimentally that the thyrohyoid muscle probably has a tautening effect on the vocal cords. He cut both

8. Vierordt, K.: Grundriss der Physiologie des Menschen, ed. 5, Tübingen, H. Laupp, 1877, p. 536.

thyrohyoid muscles of a cat and noted lowering of the pitch by three or four tones. At the same time the glottis was narrowed.

Steiner [9] (1879), on the basis of his experiments on rabbits, came to similar conclusions. He discovered that after paralysis of all intrinsic laryngeal muscles phonation is still possible "if the thyroid and the constrictor muscle are still normally innervated. But if only one of these muscles is paralyzed, voice production is no longer possible."

According to Grützner [10] (1879) the laryngopharyngeus muscle (constrictor pharyngis inferior) not only is concerned with fixing the larynx to the spinal column but, if the cartilage is sufficiently elastic, may bring about bending of the thyroid cartilage, whereby the alae of the thyroid cartilage are approximated and tension of the vocal cords is produced. Grützner used Steiner's experiments to prove his contention.

Collier [11] (1903), in his histologic investigation of a number of cases of progressive bulbar paralysis, observed definite atrophy of the extrinsic laryngeal muscles. In these cases he noted no disturbance of the movements of the vocal cords (except in a single instance, in which there was bilateral paralysis of the abductors). Aphonia was never observed, but only the lower tones of the middle register of the voice could be phonated, while the higher and the very low tones were missing. Collier attributed the voice disturbance to atrophy and paralysis of the extrinsic laryngeal muscles, and not to paralysis of the palatopharyngeal and laryngeal muscles. Moreover, the extent of voice disturbance corresponded to the intensity of the atrophy.

Dreyfuss [12] (1897) expressed the opinion that the action of the laryngopharyngeus muscle (constrictor pharyngis inferior) was especially significant in phonation. In 2 cases of bulbar paralysis with pronounced dysphagia he observed aphonia, the voice being reduced to a whisper. This disturbance Dreyfuss attributed to paralysis not of the vocal cords but of the laryngopharyngeus muscle. Laryngoscopic examination revealed that during quiet breathing the movements of the vocal cords were normal, while during phonation the cords were only slightly approximated and remained in that position for so short a time that no sound could be produced. Dreyfuss observed a similar laryngoscopic picture in a case of postdiphtheritic paralysis of the muscles of the limbs, pharynx and respiratory muscles.

Koerner [13] (1910) refused to accept Dreyfuss' view that the laryngopharyngeus muscle had any influence on the movements of the intrinsic laryngeal muscles, for, he stated, a simple consideration of anatomic specimens showed the fallacy of such an interpretation. Therefore Dreyfuss (1911) felt obliged to prove his contention by experiments on dogs. The attachment of the laryngopharyngeus muscle to the cartilages was severed on both sides, but the nerve supply to the muscle was carefully preserved. The day after the operation the expected result was noted. Swallowing was undisturbed; yet the dog could neither bark nor whine; it could only grunt. On the fifth day the dog could again bark, but the previous

9. Steiner, cited by Grützner.[10]

10. Grützner, P., in Hermann, L.: Handbuch der Physiologie, Leipzig, F. C. W. Vogel, 1879, vol. 1, pt. 2, p. 43.

11. Collier, J. S.: Rev. Neurol. & Psychiat. **1**:709, 1903.

12. Dreyfuss, R.: Ueber die Verwertung der Pharyngolaryngoskopie in der Diagnostik der Erkrankungen Centralnervensystems, Jena, Gustav Fischer, 1897; Verhandl. d. Ver. deutsch. Laryng., 1911, p. 492.

13. Koerner, O.: Ztschr. f. Ohrenh. **62**:198, 1910.

"ring" was absent. Whining was still impossible, however, since for this especially firm closing of the glottis is necessary. In a second dog the attachments of the constrictor pharyngis medius were cut, with the result that phonation was not affected but severe disturbances in swallowing occurred. Because of the similarity of the anatomic conditions in dogs and in human beings, Dreyfuss concluded that the laryngopharyngeus muscle is an important factor in phonation and that paralysis of this muscle is sufficient to cause weakness and disturbance of the voice.

Némai [14] (1916) expressed the conviction that the laryngopharyngeus muscle plays an important part in phonation by side to side compression of the thyroid cartilage. In earlier animal experiments (1912 and 1913) he demonstrated that after he had severed all motor nerves to the larynx on both sides the animal was still able to close the glottis and to produce tones of very high pitch. Némai attributed this effect to the action of the laryngopharyngeus muscle, although he could not prove his contention experimentally. This muscle is attached to the posterior margins of the thyroid cartilage. On contraction of the muscle the posterior margins approach each other, and thereby approximation of the vocal cords for phonation is rendered easier. It appears, therefore, that this muscle is especially related to the gross movements for voice production, with resultant relief of the intrinsic laryngeal muscles, which are left only with the task of the finer adductive adjustments of the vocal cords.

Stupka [15] (1921) accidentally observed on esophagoscopic study that during phonation the esophagus contracted, the shape of the lumen being similar to that of the vocal cords. He therefore made systematic observations on the movements during phonation during twenty-six esophagoscopic examinations. He found synergistic contractions, which resulted either in a rosette-like closing of the mouth of the esophagus or only in a narrowing in that region. Stupka expressed the conviction, therefore, that these movements were due to contractions of the laryngopharyngeus muscle, which Dreyfuss had described, for by this mechanism the fixation of the larynx necessary for the finer adjustments of the vocal cords by the intrinsic laryngeal musculature is brought about.

Katzenstein [16] was led to experiment on dogs by his observations on a patient, to whose case I shall refer later in detail. In these experiments he set out to determine whether the disturbance of the voice in his patient was the result of the defect in the extrinsic laryngeal musculature. First, the muscles under investigation in the dog were electrically stimulated, both individually and together, with the following results: (*a*) On stimulation of both sternohyoid muscles, the hyoid bone and the larynx moved about 1 cm. caudad, and the vocal cords became tense in a dorsoventral direction. (*b*) On stimulation of both sternothyroid muscles, slight tension of the vocal cords was produced. (*c*) On stimulation of both thyrohyoid muscles, the vocal cords became tense and slightly approached each other. In another experiment the extrinsic laryngeal muscles were severed, and the laryngeal nerves were stimulated while the vocal cords were blown on via the trachea. The pitch of the sound produced was lower than before. From these experiments Katzenstein concluded that the vocal cords are made tense as a result of the action of the extrinsic muscles, which renders phonation easier. If the extrinsic muscles are damaged, tones cannot be produced which are as high pitched as those in the normal condition.

14. Némai, J.: Arch. f. Laryng. u. Rhin. **30**:331, 1916.
15. Stupka, W.: Monatschr. f. Ohrenh. **55**:1694, 1921.
16. Katzenstein, J.: Ztschr. f. Hals-, Nasen- u. Ohrenh. **3**:438, 1922.

Kenyon [17] (1922), 1924 and 1927) presented the opinion that "a physiologic action of the vocal cords is absolutely impossible without the combined and cooperating action of both intrinsic and extrinsic muscular systems. The intrinsic musculature of the larynx possesses physiologically no power of adductive action independent of extrinsic musculature." He concluded that only the extrinsic musculature renders possible the finer closing of the glottis. This conviction (1924 and 1927) he based on numerous citations from the literature and on the results of his own experiments with palpation. Among other statements, he expressed the opinion that the vocal pitch is produced by cephalad tilting of the thyroid cartilage. "This is an act of the extrinsic musculature." Kenyon was the first to point out that the laryngologist should in all cases of obscure disorders of the voice search for disturbance of the extrinsic muscular system.

Amersbach [18] (1929) also expressed the conviction that the extrinsic laryngeal musculature has an influence on voice production. So far investigations have not clarified this problem. One can, however, take it for granted that an injury to, or even a defect of, the extrinsic musculature of the larynx results in disturbance of the voice, especially for tones of high pitch. He, too, advised investigation of the extrinsic musculature in cases of obscure disturbances of the voice.

It is of interest that such a distinguished and skilful investigator as Réthi [19] (1933) took a stand entirely different from the opinions thus far cited with regard to the activity of the extrinsic laryngeal muscles in phonation. Thus, he rejected the results of Dreyfus and Némai and stated in conclusion that "physiologically the extrinsic laryngeal musculature has nothing to do with phonation, for which it is superfluous."

On the other hand, Röttger [20] (1933) emphasized the influence of the extrinsic laryngeal muscles on the tilting of the thyroid and cricoid cartilages anteriorly and posteriorly around a frontal axis. These muscles bring about slight adduction of the vocal cords, and their tension is either raised or lowered. Röttger expressed the belief that the omohyoid muscle, together with the other muscles attached to the hyoid bone (the digastric, the stylohyoid and the mylohyoid), may have a synergic effect on these movements. Röttger is the only author who has mentioned the influence of the omohyoid muscle.

Weiss [21] (1936) observed that after thyroidectomy the range of the voice was often lowered. In agreement with the results of Katzenstein's experiments on dogs, he attributed this effect to "cutting of the outer muscles of the neck." He gave no further explanation. This observation, however, "in spite of the recovery of mobility," seems to indicate that, at least in part, the effect was due to injury of the recurrent laryngeal nerve. He also mentioned Froeschel's case of a "female tenor" in which the change in voice occurred after thyroidectomy. However, this case is not one of the type under discussion, as there still remained some paralysis of the right recurrent laryngeal nerve.

Schilling [22] (1937), as a result of experiments on cadavers, concluded that the sternothyroid muscle tilts the thyroid cartilage posteriorly and thus relaxes the vocal

17. Kenyon, E. L.: Significance of Extrinsic Musculature of Larynx, J. A. M. A. **79**:428 (Aug. 5) 1922; Laryngoscope **34**:901, 1924; Relation of Oral Articulative Movements of Speech and of Extrinsic Laryngeal Musculature in General to Function of Vocal Cords, Arch. Otolaryng. **5**:481 (June) 1927.

18. Amersbach, K., in Denker, A., and Kahler, O.: Handbuch der Hals-Nasen-Ohrenheilkunde, Berlin, Julius Springer, 1929, vol. 5, p. 848.

19. Réthi, A.: Monatschr. f. Ohrenh. **67**:572, 1933.

20. Röttger, L.: Ztschr. f. Laryng., Rhin., Otol. **24**:98, 1933.

21. Weiss, D.: Monatschr. f. Ohrenh. **70**:562, 1936.

22. Schilling, R.: Arch. Stimm- u. Sprachheilkunde **1**:65, 1937.

cords. Thereby a favorable preparatory position is set for production of the low and middle registers of the voice. Simultaneously, the sternothyroid muscle acts as an antagonist of the cricothyroid muscle and by this action releases the internal thyroarytenoid muscle for movements of the vocal cords.

I mentioned at the outset the variation of opinion expressed by different authors as to the effect of the extrinsic laryngeal musculature on phonation. The most extreme views were represented, on the one hand, by Réthi,[19] who denied any physiologic participation of the extrinsic muscles in voice production, and, on the other, by Kenyon,[17] who expressed the opinion that the intrinsic muscles exert no physiologic adductive action without the aid of the extrinsic musculature. Midway between these two views are the partially contradictory statements of various authors as to the actions of individual muscles. For example, in contrast to the tensor action of the sternothyroid muscle on the vocal cords observed by Katzenstein[16] in his experiments, Schilling[52] recently noted a relaxing action of this muscle.

How is one to reach a solution of this problem? Aside from a general discussion based, for example, on anatomic factors or on observations in vivo, there are two principal methods of promise. One is animal experimentation, and the other is accurate clinical analysis of suitable cases, which, indeed, rarely occur and which really represent experiments in vivo. Evaluation of animal experiments is always doubtful to a certain degree, for it is questionable how far results with observations on animals are applicable to human beings. On the other hand, accurate observations on living human beings, the experiment in vivo, are all too rare because of the paucity of suitable cases. Nevertheless, each case of this kind adds one more brick to the edifice of knowledge, and therefore one need not wait until a large number of cases are collected.

I shall, therefore, present a case, which was carefully studied.

REPORT OF A CASE

An accomplished singer, a mezzo-soprano and a member of a professional choir, had to undergo thyroidectomy for exophthalmic goiter. Healing was normal, and the patient quickly recovered from the operation. When she tried to resume her singing, she noticed that the range of her voice, which before operation had been from A–1 (of the small octave) to g–1 (of the two-lined octave), was now from F–1 sharp (of the small octave) to a (of the one-lined octave). She thus gained one and one-half tones in depth but lost almost an octave in height.

Examination of the voice registers revealed a well produced chest register of from F–1 sharp to d. The middle register was full and clear and began at d, rising to a. Occasionally b flat, b natural and c–1 could be reached. But these three tones sounded strained, overintense and husky and could be phonated only with noticeably cramped contractions of the extrinsic muscles of the throat. Accordingly, the uppermost notes of the middle register and the complete head register, namely, the tones up to g–1, which had been present before the operation, were now entirely missing. The notes that could still be phonated could be produced satisfactorily from the acoustic point of view. Thus, she could now sing, well and without exertion, the air from "The Messiah" for alto, "O Thou, that tellest good tidings to Zion." She had never been able to sing this easily before her operation because of its low range.

Her speaking voice was undisturbed.

Quiet breathing was regular. Moreover, breathing during singing was not faulty as long as she extended her range no higher than a. Above this, at b flat, b natural and c–1, a strong phonatory waste of breath was noticeable.

The laryngoscopic appearance was normal for the tones up to a, and was especially good with respect to mobility and ability to close the vocal cords. Above a, with b flat, b natural and c–1, complete closing of the vocal cords during phonation was no longer attainable, for the abductors of the vocal cords remained in a position of slight paresis. The huskiness of the three tones corresponded with these laryngoscopic observations. A laryngostroboscopic examination, which might have been performed for completeness of presentation, was not done, for various reasons.

The therapy consisted of systematic exercises for voice training supplemented with electrophonic compensation by means of my modification of the Katzenstein neck band electrode. The chief training procedure was the singing of an arpeggio of the three notes of a major triad; i. e., an attempt was made to slide in one of the poorly phonated notes at the end of the progression. For example, training in the first badly phonated tone, b flat, was introduced in the progression d sharp, g, b flat; then e, g sharp, b natural, and so, in half-tones upward. The treatment, in spite of the patient's excellent musical intelligence, was rather tiring. After eight weeks, the missing tones up to g–1 were sung with their earlier power and fulness of ring, and the patient could satisfactorily resume her profession.

COMMENT

Though the operation had been correctly performed and the process of healing was normal, the disturbance of the patient's voice was without doubt the consequence of her operation. It is well known that most disturbances of voice observed after thyroidectomy are due to injuries of the recurrent laryngeal nerve. However, in view of the laryngoscopic, as well as the functional, evidence, the present case is not to be included in this category.

The most striking feature of the disturbance was the absence of the higher tones, namely, the highest tones of the middle register and those of the entire head register. Therefore I first considered an injury to one of the intrinsic laryngeal muscles, the cricothyroid muscle, which plays a large part in the production of tones of the head register. In the few reported cases of isolated paralysis of this muscle, production of higher tones has been especially limited. The laryngoscopic picture of a defect of this muscle, i. e., an irregular, undulating outline of the relaxed edge of the vocal cord, is well known. Therefore, on the basis of my laryngoscopic findings, the possibility of an injury to the cricothyroid muscle had to be dismissed. Moreover, an injury to the cricothyroid muscle during the operation was not likely, in view of the hidden position of this muscle.

Kenyon's [17] and Amersbach's [18] advice to study the extrinsic laryngeal muscles in any case of voice disturbance of uncertain origin suggested the correct diagnosis. I also found in the literature the aforementioned case of Katzenstein,[16] which was extraordinarily similar to mine. Katzenstein, who assumed that the extrinsic laryngeal muscles had been injured in his case, proved experimentally the correctness of his opinion. It will be seen that my case takes one a step further in the understanding of the problem of the relation of disturbances of voice and the extrinsic laryngeal muscles.

I received the information from the surgeon that in the present case the sternohyoid, sternothyroid and omohyoid muscles had been cut and the thyrohyoid muscle left intact. This is of importance, as will be seen when this case is compared with that of Katzenstein.

In the latter case a trained soprano underwent hemithyroidectomy. The size of the goiter made it necessary to cut the sternohyoid, the sternothyroid and the thyrohyoid muscle. Some time after the wound had healed the patient noticed that she was unable to sing notes above f–1, while formerly she had been able to easily reach c–2 (of the three-lined octave). No record of the lower limit of the voice range was available. The laryngoscopic appearance, as well as the ring of the voice, was normal as long as the patient limited her range to f–1. But in trying to sing above f–1, her voice became husky and the vocal cords were incompletely adducted and, instead, remained in a position of abduction.

Although Katzenstein's patient was a high soprano and mine a mezzo-soprano, a striking similarity between the 2 cases is obvious, particularly with respect to the history, the etiologic factors and the results of laryngoscopic study, and even more especially with regard to the functional results. In the one case (Katzenstein's) the sternohyoid, sternothyroid and thyrohyoid muscles were severed, while

in the other (mine) the sternohyoid, sternothyroid and omohyoid muscles were cut. Thus, in both cases the sternohyoid and sternothyroid muscles were sectioned, but only in 1 case each was the thyrohyoid and the omohyoid muscle also cut. Nevertheless, the laryngoscopic and functional conditions were the same.

From these observations, just as in the in vivo experiment, one may conclude that cutting of the thyrohyoid or of the omohyoid muscle is not essential for production of the voice disturbances described. Katzenstein's observation that the thyrohyoid muscle in dogs had a tensor influence on the vocal cords has no importance, for in all probability this effect, if it ever occurs in human beings, is quantitatively negligible. The results of animal experiments cannot be applied to human beings without critical qualification.

I have at least established the fact, as a contribution to the solution of the problem of the influence of the extrinsic laryngeal muscles on the action of the vocal cords, that the postoperative disturbances described may appear as a result of section of the sternohyoid and sternothyroid muscles alone. From this a further conclusion can be drawn, namely, that both these muscles have an important supportive action in voice production. This action consists in aiding the tension of the vocal cords and in creating, so to speak, a basis for the finer adjustments brought about by the intrinsic laryngeal muscles. This supportive action is particularly effective in the production of high-pitched tones.

There is still the question why, when so many thyroidectomies are performed in which both these muscles are severed, the disturbances described are not observed with greater frequency. The answer may possibly be as follows: First, only rarely are such disturbances observed, since the number of thyroidectomies performed on professional singers is necessarily small and the speaking voice remains undisturbed. Furthermore, this disturbance in voice does not necessarily follow thyroidectomy, even in singers, particularly when careful attention has been paid to section of the muscles or when no extrinsic muscles are cut, a procedure which is coming into increasing favor in this country. Finally, some disturbances of voice may not reach the knowledge of the surgeon or the physician. I recently learned of such a case. The history, it is true, is not complete. But since the statements were made by a professional singer who observed herself carefully, I may report it briefly.

A singing teacher aged 49 had undergone a thyroidectomy twenty-two years before. At that time she was a high coloratura soprano (c–2 and c–2 sharp were taken easily, with beautiful tone). After the operation she could sing only up to f–1, or at best to f–1 sharp, and she could sing both these tones only under strain and was able to hold them for a short time only. Gradually, in the course of a long period, she was able to reach a–1, sometimes even b–1 flat, but she never again reached her original high tones. The voice range was not lowered. There can be no doubt that in this singer the voice disturbances came about as a result of thyroidectomy, but they were not noticed in later examinations and for that reason were not described.

I may point out that knowledge of these voice disturbances, rare though they are, is of interest not only to the laryngologist and the voice therapeutist but to the goiter surgeon. The surgeon should have all singers who are to undergo thyroidectomy closely examined before and after operation by a voice therapeutist in order that systematic orthophonic treatment of disturbances affecting the singing voice may be started as soon as possible. I believe that in my case the complete restoration of function was due to the energetic voice treatment given immediately after operation. I should recommend for treatment in similar cases the principle of the development of the missing or poor tones by the singing of

an arpeggio of the three notes of a major triad, the last of these tones being the poorly phonated one. Of course, it would be even more satisfactory if the thyroidectomies were performed without any extrinsic muscles being cut, a method which seems gradually to be increasing in favor in this country.

SUMMARY

1. Both extrinsic laryngeal muscles, the sternohyoid and the sternothyroid, have an important supportive action in voice production.

2. This action consists in aiding the tension of the vocal cords and thus in creating a basis for finer adjustments by the intrinsic laryngeal musculature.

3. This supportive action is particularly effective in the production of high-pitched tones.

Capital University.

TREATMENT OF CERTAIN FORMS OF DEAFNESS BY MEANS OF BENZYL CINNAMATE

A PRELIMINARY REPORT

JACOB JACOBSON, M.D.
NEW YORK

During the treatment of corneal opacities in 2 patients affected with interstitial keratitis and also with deafness by means of benzyl cinnamate, I noticed that with the regression of the corneal lesions the deafness also seemed to improve. I believed that in all likelihood the deafness was caused in the same way as the corneal lesions.

A priori it was possible to suppose that medication efficacious in a chronic inflammatory lesion localized in the cornea should be just as efficacious in an analogous chronic inflammatory lesion localized in the ear. The improvement seemed due to the fact that this medication introduced into the organism through the general circulation lessens exudation, congestion, infiltration and necrotic tissues of chronic inflammatory lesions of diverse nature and location.[1]

The first encouraging results obtained with this method of treatment of deafness have been published.[2]

Forty-five patients affected with deafness were treated with intramuscular injections of a solution of benzyl cinnamate from January to August 1942. These patients were chosen and observed during treatment by Drs. Julius W. Bell, M. Joseph Lobel and Hans Hirshfeld; the audiograms were taken by Dr. Augusta Jellnick.

All these patients had been treated for a long time previously by the well known classic method but without results. In addition to being hard of hearing, a great number of them were affected with dizziness and tinnitus.

The technic of the treatment is simple. The patient receives one intramuscular injection of 0.33 to 1 cc. of a 3.2 per cent solution of benzyl cinnamate for a period of twelve days. He is then allowed a period of rest of ten to fifteen days. Thereafter the injections are resumed, and after the third series of injections the patient is given one month's rest. The same cycle may be repeated after an interval of about two months.

In order that the subjective results as stated by the patient might be evaluated impartially and the autosuggestion which is frequently observed in treatments of this nature avoided, a questionnaire was sent from the social service department of the New York Polyclinic Hospital to each patient treated, regardless of whether his final results were good or bad. In this way we learned also whether the final outcome was temporary or permanent.

Of the 45 patients to whom the questionnaire was sent, 32 answered. There were 4 patients whom the questionnaire failed to reach because they had given false addresses. Nine patients did not answer. Herein I shall report only on the results in the 32 patients who answered the questionnaire.

All 32 patients had complained of loss of hearing, and 22 among them complained of tinnitus and 9 also of dizziness.

From the Research Section of the Department of Otolaryngology, New York Polyclinic Medical School and Hospital; Samuel J. Kopetzky, M.D., director.

1. Jacobson, J.: Bull. et mém. Soc. méd. d. hôp. de Paris, April 19, 1929, no. 13.
2. Jacobson, J.: Ann. d'oto-laryng., August 1938, no. 8, pp. 775-781.

AUDITION

Of the 32 who complained of loss of hearing, 17 stated that they had improved and explained how their improvement had affected their daily life.

The audiograms of conversational hearing taken before and after the treatment enabled us to divide the 17 patients into three categories: (*a*) 6 patients whose hearing had improved at least 10 per cent in the conversational range in one ear (12.5 decibels), (*b*) 7 patients whose hearing for conversation was improved at least 5 per cent (6.25 decibels) and (*c*) 4 patients whose conversational hearing was improved less than 5 per cent in one ear.

Category A.—The data on the 6 patients whose hearing for conversational frequencies improved 10 per cent (12.5 decibels) may be conveniently tabulated.

	Before Treatment	After Treatment	Gain or Loss
1. A. G. (no. 2742-42)	March 17, 1942	May 21, 1942	
	L. 32% loss	L. 28.4% loss	L. 3.6% gain
	R. 43% loss	R. 29.6% loss	R. 13.4% gain
2. M. S. (no. 3123-42)	March 26, 1942	April 7, 1942	
	L. 37.3% loss	L. 32% loss	L. 5.3% gain
	R. 30.6% loss	R. 20% loss	R. 10.6% gain
3. S. H. (no. 3226-42)	April 4, 1942	May 5, 1942	
	L. 18.6% loss	L. 9.3% loss	L. 9.3% gain
	R. 33.3% loss	R. 8.0% loss	R. 25.3% gain
4. G. B. (no. 2729-42)	March 17, 1942	April 28, 1942	
	L. 51% loss	L. 36.0% loss	L. 15.0% gain
	R. 46% loss	R. 30.6% loss	R. 15.4% gain
5. B. O. (no. 6324-41)	March 17, 1942	May 28, 1942	
	L. 34.4% loss	L. 26.6% loss	L. 7.8% gain
	R. 32.8% loss	R. 22.6% loss	R. 10.2% gain
6. E. K. (no. 36-42)	April 7, 1942	May 7, 1942	
	L. 13.6% loss	L. 4.0% loss	L. 9.6% gain
	R. 5.6% loss	R. 4.0% loss	R. 1.6% gain

Category B.—The data on the 7 patients whose hearing for conversation was improved at least 5 per cent (6.25 decibels) are tabulated likewise.

	Before Treatment	After Treatment	Gain or Loss
1. Mc. C. (no. 4108-42)	April 21, 1942	May 18, 1942	
	L. 20.0% loss	L. 14.0% loss	L. 6.0% gain
	R. 18.6% loss	R. 16.0% loss	R. 2.6% gain
2. C. L. (no. 3558-41)	Feb. 18, 1942	June 3, 1942	
	L. 40.0% loss	L. 32.0% loss	L. 8.0% gain
	R. 30.4% loss	R. 30.7% loss	R. 0.3% loss
3. D. V. (no. 2323-42)	March 10, 1942	May 22, 1942	
	L. 52.0% loss	L. 50.4% loss	L. 1.6% gain
	R. 68.0% loss	R. 60.6% loss	R. 7.4% gain
4. B. G. (no. 13354-41)	March 10, 1942	April 16, 1942	
	L. 41.3% loss	L. 37.3% loss	L. 4.0% gain
	R. 30.7% loss	R. 26.0% loss	R. 4.7% gain
5 D. T. (no. 13973-41)	April 16, 1942	June 5, 1942	
	L. 38.6% loss	L. 33.3% loss	L. 5.3% gain
	R. 37.0% loss	R. 34.6% loss	R. 2.4% gain
6. E. A. (no. 5078-40)	Dec. 30, 1941	April 14, 1942	
	L. 24.0% loss	L. 16.0% loss	L. 8.0% gain
	R. 65.0% loss	R. 60.0% loss	R. 5.0% gain
7. C. N. (no. 6250-42)	June 9, 1942	June 24, 1942	
	L. 12.0% loss	L. 12.0% loss	L. Idem.
	R. 53.3% loss	R. 45.6% loss	R. 7.7% gain

Category C.—Two patients who wore a hearing aid stated that there was an improvement, in spite of the fact that the audiograms of one showed an improve-

ment of only 2.5 per cent, and those of the other that there was no improvement in conversational hearing at all. Only the frequency cycle 128 was improved 25 decibels, and the cycle 4096, which had not been heard at all. At the time of writing this loss is 80 per cent. One patient with dizziness reported that this disappeared after the treatment and that his hearing had become clearer; his audiogram showed an improvement of 3 per cent. Another patient, whose loss of hearing was 100 per cent, bilateral, stated that his hearing showed improvement, because now he hears radio music, which he had not been able to hear for many years previously.

An improvement of more than 10 per cent in conversational hearing in one ear of a patient affected with chronic deafness, which was refractory to previous classic treatments, merits particular attention. An improvement of more than 5 per cent in conversational hearing in one ear was noted and must not be neglected either, particularly when the deafness is on the border of conversational hearing frequencies (512, 1024, 2048). Occasionally an improvement of a few decibels in such cases permit a patient to be less handicapped in his social relationships. Even an improvement of 2 to 3 per cent in conversational hearing in one ear has its value, particularly when the patient already wears a hearing aid, which amplifies and increases many times the few decibels gained.

What form of deafness would be most benefited by this method of treatment? It is too early to give a definite answer to this question. Further investigations and a greater number of observations are necessary. At the present time I have the impression that in chronic catarrhal inflammatory lesions of the middle ear, with conductive deafness, the results are encouraging. The reason is that a chronic inflammatory lesion creates an obstacle to the passage of the sound waves necessary to activate the acoustic nerve. The medication facilitates reabsorption, which eliminates inflammatory lesions; hence the passage for the sound waves becomes more free and the acoustic nerve ends receive more stimulation.

TINNITUS

Of the 32 patients treated, 24 complained also of tinnitus, according to the answers to the questionnaires. Two patients reported disappearance of the tinnitus. Seven patients stated that tinnitus was diminished in intensity. Fifteen patients stated that there was no change in their tinnitus.

The patients who reported an improvement complained mostly of tinnitus with a bell-like character or of hammering and pounding noises. The patients whose tinnitus remained unchanged complained mostly of continuous tinnitus, whose character was like a passage of steam. It is presumed that the anatomic lesion is not always the same in various types of deafness, all of which are grouped under one generic diagnostic designation.

During the treatment the tinnitus often becomes even stronger, but this is very temporary. It may be explained by the fact that the circulation in the ear is increased. As a matter of fact, during the treatment, after five to seven injections, in many cases a temporary appearance of vessels is noticed on the malleus and on Shrapnel's membrane.

The vascular reaction goes on without inflammatory symptoms. This reaction is temporary and usually precedes any improvement that the patient may notice. The details of this vascular reaction I have studied clinically and experimentally in cases of corneal opacities.[3]

3. Jacobson, J.: Bull. Soc. d'opht. de Paris, Dec. 19, 1936, p. 775.

DIZZINESS

Of the 32 patients treated, 9 complained at the same time of dizziness, according to the answers to the questionnaires. Three patients reported it's disappearance. Five patients reported that it was diminished. One patient reported no change.

Among the patients with dizziness a certain number were affected with Ménière's syndrome. Two patients who presented typical Ménière's disease had been treated for several years without improvement. After the first course of injections a satisfactory result was reported.

SUMMARY

Further experimentation should be carried out, and as time goes on perhaps it may be possible to judge better the exact results of treatment of deafness with benzyl cinnamate and to determine more exactly the types of deafness to which it should be applied.

At the present time let me limit myself to the fact that a simple method, painless and harmless, proved effective in reducing severe deafness in a relatively short time in about 50 per cent of cases, in reducing or eliminating dizziness in 90 per cent of cases and in reducing or eliminating certain types of tinnitus. Not only have the patients reported that their suffering has been lessened, but they have mentioned improvement to a varying degree in their social relationships.

51 West Eighty-First Street.

Case Reports

AUDIOMETRIC EFFECTS OF VOLUNTARY CONTRACTION OF THE TENSOR TYMPANI MUSCLES

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Voluntary and involuntary contractions of the tensor tympani muscles were recognized by Politzer, Luschka and others nearly one hundred years ago. Politzer [1] reported, in discussing 1 of his cases, that "during the contractions the hearing distance was diminished, the deep tones became deadened and indistinct, and the high tones ascended about one quarter of a tone."

A number of similar cases have been reported since that time, but so far as I could determine there is no audiometric record of the effects of voluntary contraction of the tensor tympani muscle in the medical literature. Therefore this case is

Fig. 1.—Appearance of the membrana tympani during contraction of the tensor tympani muscle.

presented in the hope that the observations may help in the interpretation of audiometric records of loss of hearing.

REPORT OF A CASE

Lieut. W. B., in a routine examination, was found to be able to contract his tensor tympani muscles voluntarily. The membrana tympani retracted, and the handle of the malleus moved posteriorly and appeared to shorten, according to the criteria laid down by previous authors. There were no other contractions of the musculature; the soft palate and the nasopharyngeal

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Read before the San Antonio Ophthalmo-Oto-Laryngological Society, San Antonio, Texas, Feb. 9, 1943.

1. Politzer, A.: Diseases of the Ear, ed. 5, London, Baillière, Tindall & Cox, 1909.

ostiums of the eustachian tubes were watched particularly. The subject was examined by four other members of the department.

The lieutenant first became actively conscious of his ability at about 8 or 9 years of age. At that time he had several episodes of bilateral otitis media, and he found that a certain maneuver increased the pressure and pain in his ears. He felt that he had always been able to perform the act, but had never had it brought to his attention before.

Subsequently, he found that this maneuver would produce a low-pitched roar in both ears and diminution in hearing sufficient to block out ordinary conversation. He said that he had used this ability, for example, to exclude extraneous noise or boring conversation or to shut out the end of a movie when he entered a theater late. Both ears were affected simultaneously, and he felt that he had acquired somewhat better control and efficiency, but not to any great extent. The strength of the contractions could be adjusted from a barely perceptible twitch to a contraction of maximum intensity, as judged subjectively. However, it was difficult to maintain a steady contraction except at or near maximum intensity. This maximum intensity could be maintained for twenty to thirty seconds; then the muscles had to be rested for ten to fifteen seconds, after which they could be contracted again.

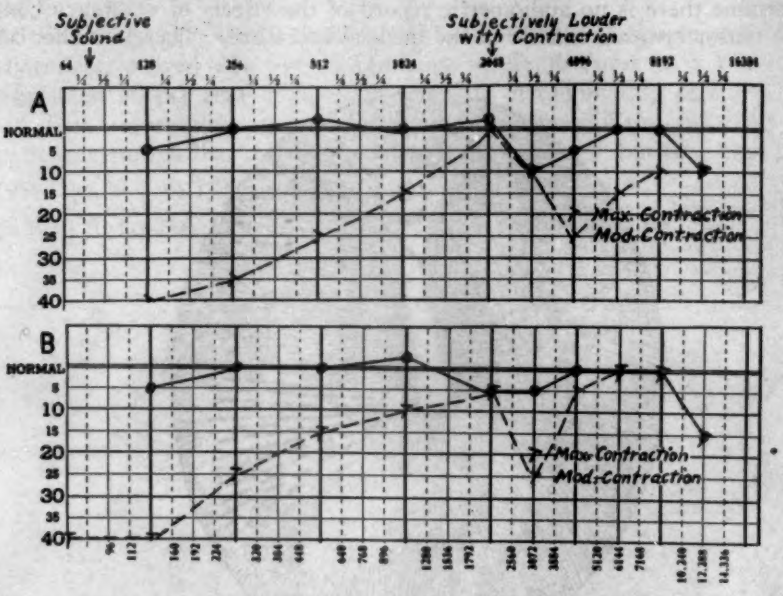

Fig. 2.—Audiograms for the left (*A*) and the right (*B*) ear of Lieut. B., demonstrating the loss of hearing due to contractions of the tensor tympani muscles. The line with circles represents normal hearing; the *T* line, hearing during contraction of the tensor tympani muscles. The subjective roar in the ears appears to correspond to a tone just above 64 cycles. The loss of hearing gradually decreases at 2048 cycles. The subject felt that the hearing at 2048 cycles improved about 5 decibels during contraction of the muscles, but this subjective increase in hearing could not be demonstrated in the audiogram. The secondary diminution in hearing for high tones was unexpected, but constant. The lower *T* at 2896 cycles for the right ear and at 4096 cycles for the left ear was the hearing loss with moderate contraction of the tensor tympani muscles. The *T* just above was the hearing loss during strong contraction of the muscles.

Occasionally loud noises caused reflex contractions of the tensor tympani muscles after the peak of the intensity. "This is very inconstant, but I can usually bring it on by slightly contracting the muscles, 'setting' them, so to speak, when the roar will rise and fall with the amplitude [intensity] of the loud sounds, following them with no appreciable lag." It has been estimated that the latency of the contractions of the tensor tympani and stapedius muscles to the sudden stimulus of a loud tone is fourteen to sixty milliseconds.[2] The maximum intensity is attained in one hundred to one hundred and fifty milliseconds.

2. Fowler, E. P.: Loose Leaf Medicine of the Ear, New York, Thos. Nelson & Sons, 1939.

COMMENT

The question of associated contractions of the stapedius muscle during the observed activity of the tensor tympani muscle arises. Politzer, Lucae and Gottstein [1] have reported strong contractions of the orbicularis oculi muscle with contraction of the stapedius muscle, apparently without any activity of the tensor tympani muscle being manifested. This contraction of the orbicularis oculi muscle was observed intermittently with Lieut. B. However, when his attention was called to the additional factor, he was able to produce the objective and subjective indications of contraction of the tensor tympani muscle without any signs of action of the stapedial muscle. Even when there was evidence of contractions of both the tensor tympani and the stapedius muscle, no difference in the audiogram could be demonstrated with respect to the effect of the tensor tympani muscle alone.

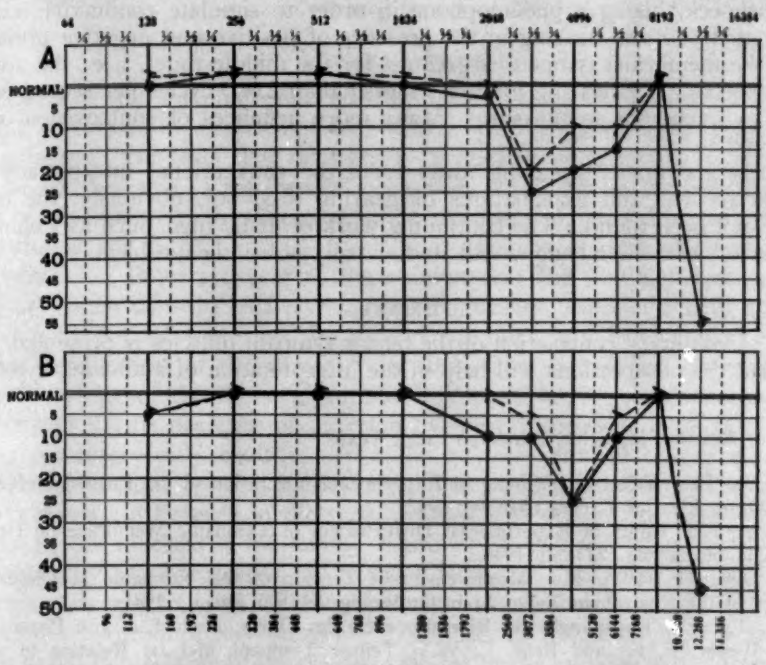

Fig. 3.—Typical audiograms for (*A*) the left and (*B*) the right ear during contraction of the pharyngeal muscles.

The lines of circles represent normal hearing; the *T* lines, hearing during contraction of the pharyngeal muscles. The improvement in hearing for high tones was probably due to opening of the eustachian tubes and equalization of the pressures on the two sides of the drum membrane, giving optimum hearing.

After Lieut. B. was tested a number of officers stated that they could produce a comparable roar in their ears. Examination of these men showed contraction of the pharyngeal musculature. None of the criteria for contraction of the tensor tympani muscle could be seen, and the audiograms did not change except for slight improvement in the hearing for high tones.

The interpretation of audiometric records of patients with loss of hearing is in the process of alteration. It has been the accepted belief that conduction deafness was characterized by a reversal of air and bone conduction and a loss of hearing for low tones and that perception deafness showed a loss for high tones. Contraction of the tensor tympani muscles, as demonstrated by the audiograms of Lieut. B., and postulated by previous observers, does produce a diminution in hearing for low tones.

Occlusion of the eustachian tube causes retraction of the membrana tympani and seems to place the aural conduction mechanism in a condition somewhat similar to that produced by contraction of the tensor tympani muscles. However, Loch[3] occluded his eustachian tubes with a soft rubber balloon and found that, during a period of obstruction ranging from ten to seventy-five minutes, there was an increasing loss of hearing for high tones, with a delayed, secondary, lesser loss for the middle and low tones. Loch's work confirmed the clinical impressions of Crowe, Baylor and Guild that an uncomplicated tubal occlusion resulted in a loss of hearing for high tones, which was followed by a lesser loss for the other tones.

Lüscher[4] studied the audiometric effects of various types of pressure on the membrana tympani by the use of weights and drops of mercury and water of known amounts. He concluded that a pure conduction disturbance affects mainly hearing for the middle and high notes and lowers hearing for tones in the upper range.

Van Dishoeck,[5] using a pneumophone in order to simulate conductive lesions, reported that the loss of hearing in the presence of positive and negative pressures applied to the membrana tympani is greatest for the middle tones, i. e., the area of colloquial speech. The hearing for tones higher than 2,000 cycles per second is not influenced by variations in pressure. Many more instances of controversial work could be cited.[6]

Otologists are finally breaking away from the conventional interpretation of audiometric records and explanations of hearing loss, but, obviously, the entire answer has not been found. The continuing work of many men, such as Pohlman,[7] Crowe, Lurie[8] and Shambaugh, will undoubtedly solve the problem.

SUMMARY

A case of voluntary contraction of the tensor tympani muscles is presented, with the hope that the observations will help in the interpretation of audiometric records of hearing loss.

School of Aviation Medicine, Randolph Field, Texas.

3. Loch, W. E.: Effect on Hearing of Experimental Occlusion of the Eustachian Tube in Man, Ann. Otol., Rhin. & Laryng. **51**:396, 1942.

4. Lüscher, E.: Effect of Experimental Disturbances of Tympanic Membrane on Hearing Capacity, Acta oto-laryng. **27**:250, 1940.

5. Van Dishoeck, H. A. E.: Measurement of Tension of the Tympanic Membrane and of Resistance of the Eustachian Tube, Arch. Otolaryng. **34**:596 (Sept.) 1941.

6. Kato, T.: Zur Physiologie der Binnenmuskeln des Ohres, Arch. f. d. ges. Physiol. **15**: 569, 1913. Wever, E. G., and Bray, C. W.: Tensor Tympani, and Its Relation to Sound Conduction, Ann. Otol., Rhin. & Laryng. **46**:947, 1937; The Stapedius Muscle in Relation to Sound Conduction, J. Exper. Psychol. **31**:35, 1942. Kobrak, H. G.; Lindsay, J. R.; Perlman, H. B., and Dubner, H.: Effect of Limited Cochlear Lesions on Cochlear Potentials and Middle Ear Muscle Reflexes, Arch. Otolaryng. **27**:59 (Jan.) 1938. Wiggers, H. C.: Functions of Intra-Aural Muscles, Am. J. Physiol. **120**:771, 1937. Mao, C. Y., and Hughson, W.: Patency of the Eustachian Tube in Relation to Profound Hearing Loss in Childhood, Arch. Otolaryng. **33**:824 (May) 1941.

7. Pohlman, A. G.: The Reactions in the Ear to Sound, Ann. Otol., Rhin. & Laryng. **50**:363, 1941.

8. Lurie: Studies of Acquired and Inherited Deafness in Animals, J. Acoust. Soc. America **11**:420, 1940.

Progress in Otolaryngology

Summaries of the Bibliographic Material Available in the Field of Otolaryngology

THE PARANASAL SINUSES

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(Continued from page 294)

SURGICAL THERAPY

Bowers [84] offers a number of observations on the general problem of sinusitis and its treatment in an attempt to evaluate and reconcile conflicting statements and opinions. He feels that divergence of opinion as reflected in the literature may be ascribed to (1) differences in climate, which are responsible for different types of infection; (2) the type of practice, institutional, clinical or private; (3) the reputation of the author, and (4) the author's criteria of diagnosis and indications for operation. Bowers expresses the opinion that the Caldwell-Luc operation is necessary when constitutional symptoms are present, especially with reference to the tracheobronchial tree, and the roentgenographic and local evidence points to chronic involvement of the sinuses. In such cases he advises complete removal of every vestige of the mucosa, since it is impossible to determine the extent of involvement or the presence of infection by mere inspection of portions that may appear macroscopically healthy. Also, he advises removal of the ethmoid cells through the antrum opening if they appear diseased. His bacteriologic examinations revealed a difference in the type of organisms present in the nose and those present in the mucosa of the sinus. Cultures of material from the nose yielded predominantly Staphylococcus, while those from the sinus mucosa showed usually Streptococcus viridans. This difference, in his opinion, accounts for the failure of vaccines to produce any results. In discussing irrigation of the antrum, the author noted that a large opening was available in the middle meatus in 65 per cent of 1,223 cases.

In general the article is conservative, with special emphasis on the necessity of one's having an open mind and judging reports on the basis of the location from which they emanate, the reputation of the author, the type of practice forming the basis of the report and the data brought to bear in the argument.

Hollender,[85] in attempting to evaluate the results of surgical treatment of the sinuses, reviewed 250 of his own cases and analyzed 154 responses to a questionnaire addressed to 400 representative rhinologists. He concludes that the causes of failure may be listed as follows: "(1) incorrect diagnosis of the existing conditions; (2) failure to take account of allergic factors; (3) lack of recognition of the role of organic diseases; (4) hasty surgical intervention without adequate trial of non-surgical treatment; (5) ill performed or incomplete operation; (6) inadequate postoperative management."

84. Bowers, W. C.: Practical Points in Diagnosis and Treatment of Sinusitis, Arch. Otolaryng. **36**:327 (Sept.) 1942.

85. Hollender, A. R.: Nasal and Sinus Surgery: A Critical Review of the Causes of Unsuccessful End Results, South. M. J. **35**:363 (April) 1942.

He obtained 71 per cent of cures from operations on the nose and 42 per cent from operations on the sinuses. Suggestions of means by which surgical results may be improved are: "(1) more accurate diagnosis; (2) greater care in selection of patients for operation; (3) increased consideration of allergic aspect; (4) more rational application of surgical procedures based on newer physiologic concepts, and (5) more adequate postoperative management."

Connor [86] reviews the history of nasal sinus surgery and traces the progress in this field from the beginning. Also, he points out the varying anatomic features of these cavities and their bearing on surgical indications and discusses the conditions which militate against a cure. The author inclines toward conservatism in treatment whenever possible, in the hope that normal contours may be preserved and nature aided.

Golden [87] discusses the whys and wherefores of the distrust on the part of the laity and some general practitioners of surgical therapy of the sinuses and concludes that the fault lies in inappropriately applied and incomplete surgical procedures. He feels that the best of skill and experience on the part of the rhinologist is needed to determine when surgical treatment should be employed, and that when such therapy is undertaken it should be thorough and adequate. Bad results are frequently the result of unskilful, as well as misapplied, surgical procedures.

Bryant [88] stresses the importance of the middle turbinate in the normal physiologic condition of the nose and the necessity of preserving it at all costs. He claims that rhinologists remove fewer turbinates now than in former years. When the middle turbinate is so diseased as to necessitate removal, the ethmoid cells are at the same time involved to a degree requiring operation. In cases of such a condition the author prefers the external operation because it affords better visualization of the field and easier access to the diseased cells. In all other cases the author feels that conservative measures will suffice. This applies especially to cases of acute disease. In other instances infraction of the turbinate will assist drainage, and in cases in which the turbinate bone is the site of an extended cell partial resection will suffice.

Goodale [89] presents an analysis of the results obtained over an eight year period in a series of 190 operations on the frontal sinus. Of these, 123 were performed for the cure of infection, and 38 of these necessitated a secondary operative procedure. There were 18 operations for mucocele, with 4 recurrences. Most of the failures were due to the presence of adhesions, frontoethmoid cells and ethmoid extensions into the roof of the orbit. Three of the 4 Killian procedures required a second operation. Of 106 operations of the Lynch type, 30 proved inadequate and a second operation had to be done. The author concludes that whatever operative procedure is undertaken, it is important that the technic be meticulous and thorough, with complete removal of the floor of the sinus, especially toward its external extremity. Also, the ethmoid cells and the sphenoid sinus should in every can be thoroughly cleaned out. Finally, prolonged postoperative care is highly essential to prevent adhesions and pocketing of unhealed areas.

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86. Connor, C. E.: Present Status of Surgery of the Accessory Nasal Sinuses, Minnesota Med. **25**:97 (Feb.) 1942.

87. Golden, M. G.: Abandonment of Sinus and Mastoid Surgery? M. Times, New York **70**:273 (Aug.) 1942.

88. Bryant, F. L.: The Relation of the Middle Turbinate to Paranasal Sinusitis, Journal-Lancet **62**:99 (March) 1942.

89. Goodale, R. L.: Some Causes for Failure in Frontal Surgery, Ann. Otol., Rhin. & Laryng. **51**:648 (Sept.) 1942.

Boies [90] presents 4 cases of acute frontal sinusitis with external edema and symptoms of inadequate drainage, which yielded promptly after a small trephine opening had been made in the floor of the sinus. He points out that if the opening is made posterior to a line drawn upward from the posterior lacrimal crest, one is not likely to encounter any diploic bone and that therefore the procedure is without danger of inciting osteomyelitis. A minimum of trauma is involved, since no curetting of the bone or sinus mucosa is permitted. Drainage is effected by means of a small rubber tube. In all the cases cited operation was carried out within two to five days of the onset of the symptoms. The author believes that this procedure, when supported by adequate therapy with sulfonamide compounds and local shrinkage, not only is safe but may be the means of warding off more serious complications.

Patterson [91] discusses the merits of the external approach for the eradication of disease of the various sinuses, particularly the ethmoid cells. His objection to the transantral approach to the ethmoid cells is based on the possibility of greater hemorrhage, the inaccessibility of the topmost cells and the greater danger of infection from the mouth. He describes two incisions for the external operation which he calls "ethmoid" and "frontal." The ethmoid incision, which is placed in a furrow in the skin of the cheek below the lower eyelid, is employed when the ethmoid cells, the antrum and the sphenoid sinus are to be cleaned out. The frontal incision is the usual one in the brow, and he advises its use for the combined operation on the frontal and ethmoid sinuses. Most of the technic is similar to that usually carried out in this country. Some of the refinements suggested are sewing together of the lids, making of the incision on a bevel, blunt separation of the fibers of the orbicularis oculi muscle and use of temporary gut sutures for retraction. He advises thorough and systematic opening of all ethmoid cells, amounting to total ethmoidectomy, from the roof down to the maxillary sinus, the latter being opened through the middle meatus as a result of the removal of the ethmoantral cells. He believes that the antrum can be dealt with adequately through this large opening and that the inferior meatus need not be opened. The author removes a portion of the ascending process of the superior maxilla, a procedure which some authors have recently decried as being one of the factors tending to collapse of the nasofrontal duct.

Queiroz Muniz [92] reports a case of severe hemorrhage occurring seven days after a transantral operation on the ethmoid cells. The patient had undergone the same operation on the other side ninety days previously, without accident. After the earlier operation the patient had a severe hepatic and intestinal upset, which caused the delay in operation on the second side. The author believes that the hemorrhage which occurred after this operation was due to hepatic insufficiency, resulting in a disturbance of vitamin metabolism, which was reflected in an insufficiency of prothrombin. The hemorrhage was controlled by injections of a preparation of prothrombin, vitamin K and dextrose. The operative cavity was opened; the clots were removed, and packing was inserted. The patient recovered.

90. Boies, L. R.: Acute Frontal Sinusitis: The Trephine Operation for Drainage in Selected Cases, Laryngoscope **52**:458 (June) 1942.

91. Patterson, N.: External Operations on the Nasal Accessory Sinuses, Arch. Otolaryng. **36**:311 (Sept.) 1942.

92. Queiroz Muniz, A.: Accidente tardio na operaçõ de Ermiro de Lima, Rev. brasil. de oto-rino-laring. **9**:397 (Sept.-Oct.) 1941.

Smith [93] presents a modification of the Thornwald drill for use in the sphenoid sinus and explains that by this means it is easy to make an opening into the sinus, through which it may be irrigated.

NONSURGICAL THERAPY

General Considerations.—Weille [94] gives a practical discussion of the therapy of sinusitis and offers a number of suggestions which he has found helpful in his own experience. On the whole he is extremely conservative and does not recommend surgical intervention as long as conservative measures yield results. He postulates the following dictums: 1. "Make an accurate diagnosis." He believes that the clinical findings combined with the results of experienced roentgenologic examination should yield a 90 per cent accuracy in diagnosis. 2. "Never resort to operation as long as adequate progress can be made by conservative treatment." He claims that the danger of being overcautious is much less than that of ill advised, premature surgical intervention. 3. "Never damage the function of normal nasal structures." 4. "Endeavor to relieve swelling of the nasal mucosa in the region of sinus ostia." He advises against irrigation of a sinus as long as it drains adequately through the natural ostium. 5. "Strong suction must never be applied to the nasal cavities as a whole." Instead, he recommends the use of low pressure suction with a small cannula, a metal catheter being applied directly to the region of the sinus ostium. With respect to treatment with sulfonamide compounds the author is reserved. He feels that sulfadiazine is a valuable drug in cases of serious infection but does not advise its use as a routine measure.

With respect to the use of sprays, Weille mentions ephedrine hydrochloride, 1 per cent, and neo-synephrin hydrochloride, 0.25 to 1 per cent. Also, he is not averse to the use of chlorobutanol inhalant or camphor in liquid petrolatum, discounting the danger of lipoid pneumonia as being too remote with the average patient. Nasal tampons are used. He cautions against "packing" the nose and suggests that the tampons be placed in the nasal cavities without pressure. Short wave and roentgen therapy are recommended for promotion of resolution after the acute symptoms have subsided.

In cases of chronic sinusitis, the author advises caution in the recommending of surgical therapy. In some instances the recurrence of polyps may be prevented by use of coagulation diathermy. In other cases skilful local therapy combined with adequate hygienic and constitutional measures will go a long way toward effecting a cure. When operation is indicated, one should be careful to eliminate allergic factors before undertaking the procedure. Also, anatomic deformities tending to block drainage should be corrected. In some cases the author has been agreeably surprised at the effects of treatment with sulfonamide compounds alone and feels that these drugs may come into wider use when they are properly indicated and applied.

Van Alyea [95] covers the subject of acute sinusitis thoroughly and discusses the various procedures in common use. In the early stages he has found administration of vitamin C of value in daily doses of 1 grain (0.065 Gm.), and believes that

93. Smith, H. D.: Sphenoid Sinus Drill, Arch. Otolaryng. **35**:132 (Jan.) 1942.

94. Weille, F. L.: The Treatment of Sinusitis, M. Clin. North America **26**:1511 (Sept.) 1942.

95. Van Alyea, O. E.: Treatment of Acute Infections of the Nose and Sinuses, Kentucky M. J. **40**:441 (Nov.) 1942.

vitamin therapy of sinus disease offers a fertile field for investigation. He is not committed to the use of sulfonamide compounds except in cases in which fever is present. He comments favorably on the use of the Dowling pack in connection with the infra-red lamp. He advocates infraction of the middle turbinate when it obstructs drainage and irrigation after the acute symptoms have subsided.

Birdsall [96] is impressed with the necessity of "curing" acute sinusitis in recruits to forestall the development of a chronic condition, with all its attendant disabilities. For keeping the ostium of the sinus open he recommends a spray containing 4 per cent cocaine, 1 per cent ephedrine hydrochloride, 0.5 per cent potassium sulfate and 0.5 per cent chlorobutanol. Steam inhalations of menthol, oil of pine needles or compound tincture of benzoin are used, and if the secretions are profuse, especially in that they are mucopurulent, he advises insufflation of a solution of alkaline solution B. P. (sodium bicarbonate, sodium borate, phenol and sucrose in distilled water). If pain and fever persist more than twenty-four hours, the author recommends puncture and irrigation of the antrum. Cure is determined by a follow-up roentgenogram, with use of a contrast medium if necessary.

For chronic maxillary sinusitis the author advises a Caldwell-Luc operation, with exenteration of the ethmoid cells if they are concomitantly involved.

Gill-Carey [97] states that in many cases acute sinusitis is not diagnosed early because of unorthodox symptoms, particularly pain in regions other than the area directly over the sinuses. The presence of the disease should be suspected in all cases of otitis media, simple colds and infections of the influenza type. Sinus pain is considered under three heads: obstructive, osteitic and neuralgic. Pain due to obstruction is confined to the region of the sinus, is most intense in the forenoon and is increased by exertion. Osteitic pain is more constant and is unrelieved by drainage. Neuralgic pain is usually due to involvement of sensory nerve fibers and gives rise to pain referred to other organs, such as the ears, the pharynx and various portions of the scalp. In the treatment of acute sinusitis the author has found the use of vitamin C in rather large doses (400 to 500 mg. of ascorbic acid daily) of great value. He stresses the value of intelligent administration of the sulfonamide compounds when indicated, it being always borne in mind that the infected focus must be adequately drained in any case. Also, the author stresses the importance of careful observation in all cases of acute sinusitis in order to clear up residual infection and to remove possible contributing causes of recurrence.

Henley [98] reviews much of the recent literature on the treatment of sinus infections, citing many authors and explaining the rationale of the therapy advocated.

Nodine [99] presents a brief résumé of the therapy he usually employs under various conditions. He believes in extreme conservatism in treatment of acute sinusitis except when intracranial complications threaten, in which case he advocates radical measures. In most cases of chronic infection he likes displacement therapy, along with administration of vitamins. In infections of the antrum he uses 20 per cent iodized poppyseed oil after irrigation for several treatments.

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96. Birdsall, S. E.: The Treatment of Sinusitis in Recruits, M. Press **208**:153 (Sept. 2) 1942.

97. Gill-Carey C.: The Management of Acute Nasal Sinusitis and Its Complications, Practitioner **148**:70 (Feb.) 1942.

98. Henley, M. D.: Recent Advances in Treatment of Acute Chronic Sinus Infection, J. Oklahoma M. A. **35**:463 (Nov.) 1942.

99. Nodine, E. R.: Modern Treatment of Sinal Disease, J. M. A. Alabama **11**:199 (Dec.) 1942.

Drugs; Chemotherapy.—Chambers, Harris, Schumann and Ferguson [100] reported on a method of reducing the crystals of the sulfonamide compounds to such small size as to make them soluble in isotonic solution of sodium chloride and thus permit their use by injection and instillation in various cavities of the body. This was done by subjecting neutral solutions of the drug to violent agitation through sound waves. Silcox and Schenck [101] used a 5 per cent suspension of microcrystals of sulfathiazole in either isotonic solution of sodium chloride or a 1 per cent aqueous solution of paredrine hydrobromide (p-hydroxy-a-methyl-phenethylamine hydrobromide) in the treatment of acute and chronic infections about the head and in a number of cases of sinusitis, with excellent results. The new preparation possesses the advantage over the older suspensions that the drug remains in more or less permanent solution, can be easily passed through a 26 gage needle and, after its introduction into the antrum, remains as a firmly divided powder over the surface of the mucosa for as long as five days. Thus, the danger of local irritation and too rapid absorption is avoided, and the action of the drug is prolonged long enough to permit effective bacteriostatic action, at least sufficient to control the infection in the majority of cases. The authors report 18 cases of acute unilateral maxillary sinusitis in which a 5 per cent suspension of microcrystals of sulfathiazole in isotonic solution of sodium chloride was employed and the infection subsided in an average of three days. Further, the employment of this treatment in 27 cases of acute infections of the upper respiratory tract resulted in fewer complications than occurred in a control group of 22 cases in which conventional methods of therapy were used. In 52 cases of acute and chronic sinusitis a 5 per cent suspension of microcrystals of sulfathiazole in a 1 per cent aqueous solution of paredrine hydrobromide, given in the form of instillations, sprays, drops, displacement therapy or irrigation, yielded uniformly good results. No untoward effects were observed. Also, in 14 cases of chronic maxillary sinusitis in which the Caldwell-Luc operation was performed and the 5 per cent suspension was used after operation, healing was more rapid, with a minimum of discharge, odor or crusting.

Brown [102] describes a method of introducing sulfanilamide powder directly into an infected sinus and claims to have had brilliant results in 5 typical cases, which he cites. The procedure is advocated in cases of chronic purulent sinusitis, such as might usually be treated by radical operation. The technic involves hospitalization of the patient, who may be operated on with either local or intravenous anesthesia. If necessary the septum is resected, and then the anterior half of the middle turbinate is removed. The ostium of the maxillary sinus is enlarged with a sphenoid punch to at least three times its normal size. The anterior ethmoid cells are removed so as to free the nasofrontal duct, which is enlarged with a rasp until it freely admits a no. 3 eustachian catheter. The frontal and maxillary sinuses are irrigated with isotonic solution of sodium chloride and then dried by a cloud of air, after which the sulfanilamide powder is insufflated through the catheter with a common powder blower. The ethmoid area is also covered with a layer of powder. The irrigation and insufflation of powder are repeated twice weekly for several weeks. The author states that in the original procedure the patient frequently complained of severe pain but that this symptom was absent at the subsequent treatments.

100. Chambers, L. A.; Harris, T. N.; Schumann, F., and Ferguson, L. R.: Use of Microcrystals of Sulfathiazole in Surgery, J. A. M. A. **119**:324 (May 23) 1942.

101. Silcox, L. E., and Schenck, H. P.: Use in Otolaryngology of Microcrystals of Drugs of the Sulfanilamide Group, Arch. Otolaryng. **36**:171 (Aug.) 1942.

102. Brown, L. A.: Intrasinal Application of Sulfonamide Powder, Ann. Otol., Rhin. & Laryng. **51**:611 (Sept.) 1942.

On the basis of Pickrell's treatment for burns, Bordley, Crowe, Dolowitz and Pickrell,[103] in a series of patients and in an equal number of controls, tried out the solution (2.5 per cent sulfadiazine in 8 per cent triethanolamine) in the form of a nasal spray for the prevention of pyogenic complications of the common cold. They found a definite reduction in the percentage of sinus complications in the patients so treated as compared with the control group. Also, they found that the spray seemed to prevent the irritating cough frequently associated with acute nasopharyngitis. Eight treatments of from 1.5 to 2 cc. of the solution were given daily for the first two days and five or six treatments for the next two or three days. Frequent bacteriologic studies disclosed a rapid and notable decrease in the bacterial colonies in the treated patients as compared with the controls. Only 3 per cent of the patients were found to be sensitive to the drug, as manifested by a vasomotor reaction.

Marks[104] recommends the use of sulfathiazole suspended in a jelly in 20 to 50 per cent concentrations for injection into the maxillary sinus in the treatment of chronic infections and claims it is successful in about 70 per cent of cases. He cites 10 cases, in which the organism recovered was generally a staphylococcus and the duration of the infection ranged from three months to six years; in 70 per cent good results were obtained with treatments over a period of two to six weeks.

Connell and Trowbridge,[105] commenting on the local use of sulfonamide compounds, claim that sulfanilamide powder or sulfathiazole blown into the nasal cavities with a Lederman insufflator in treatment of acute rhinitis may give considerable relief, even to the point of aborting the process. They state that the presence of the powder does not impair the rate of ciliary activity. They also recommend its use in wounds or cavities after operative procedures on the septum, ethmoid cells or nose.

Hunnicutt,[106] employing a 5 per cent solution of sodium sulfathiazole in the nasal cavities of mice, showed by subsequent histologic examination of the tissues that the solution caused no permanent ill effects. For the first few days he found only a mild local inflammatory reaction, with no destruction of vital functioning cells. This mild reaction was observed to subside within a few days.

Sternstein,[107] by means of an apparatus which he had previously described, conducted experiments with various vasoconstrictor drugs to determine their efficacy. It was found that ephedrine hydrochloride was more effective than cocaine hydrochloride except when the latter was combined with the ephedrine. Amphetamine and neo-synephrin hydrochloride were found to be more effective than natural ephedrine. Neo-synephrin hydrochloride (0.25 per cent) seemed to be the most efficient agent of all.

Felderman[108] recommends instillation into the nose of a 0.1 to 0.2 per cent solution of silver picrate in 7.5 per cent solution of dextrose in the treatment of

103. Bordley, J. E.; Crowe, S. J.; Dolowitz, D. A., and Pickrell, K. L.: The Local Use of the Sulfonamides, Gramicidin and Penicillin in Otolaryngology, Ann. Otol., Rhin. & Laryng. **51**:936 (Dec.) 1942.

104. Marks, R. F.: Sulfathiazole in the Treatment of Sinusitis, Arch. Otolaryng. **35**:794 (May) 1942.

105. Connell, E. S., and Trowbridge, B. C.: Local Use of Sulfanilamide and Its Derivatives in the Ear, Nose and Throat, Arch. Otolaryng. **35**:740 (May) 1942.

106. Hunnicutt, L. G.: Reaction of Mucus Membranes to Five Per Cent Solution of Sodium Sulfathiazole, Arch. Otolaryng. **36**:837 (Dec.) 1942.

107. Sternstein, H. J.: Efficacy of Vasoconstrictor Agents in the Obstructed Nose, Arch. Otolaryng. **36**:713 (Nov.) 1942.

108. Felderman, L.: The Use of Silver Picrate in Sinus Infections: Report of 200 Cases, Pennsylvania M. J. **45**:232 (Dec.) 1941.

acute head colds, with or without sinus complications. His experience with this drug in a series of 200 cases was satisfactory, since the bacterial count diminished rapidly, with improvement in the symptoms. In only 12 cases was surgical treatment required.

Howe [109] calls attention to hyponuclemia as a possible cause of chronic sinusitis in children and describes the symptom complex in accordance with the original contribution of Hetler. This complex consists of a pale, pasty complexion, pallor, excess weight and an appearance of "pseudorobustness." The author also has found the following symptoms characteristic: loss of appetite, sluggishness, indifference to play, soft, flabby flesh and retarded growth. The condition is thought to be due to faulty diet, imperfect gastric function or a persistent loss of nucleic acid due to discharges from the sinuses or recurring nasopharyngeal infection; deficiency in nucleic acid results in failure of the liver and kidneys to perform their detoxifying functions, which accounts for the swollen, pasty appearance and the general sluggishness. The author cites a number of typical cases and describes the treatment with nucleic acid. Children under 10 years are given 10 grains (0.65 Gm.) of nucleic acid mixed in water, milk or orange juice twice daily one half-hour before meals until the symptoms recede, when the frequency of administration is lessened. After apparent return to normal the acid is given on alternate weeks for several months. In children over 10 years of age the dose is 15 grains (0.975 Gm.). Also, the diet is strengthened in nucleic acid–containing foods, and in cases of prolonged deficiency the patient is given adrenal cortex extract orally, which counteracts the tendency to dehydration and increases the thyroid function. Infected sinuses should be drained and adenoids and tonsils removed if they are diseased or obstructive.

According to Ruskin,[110] animal experiments have revealed the effectiveness of combining the ascorbic acid radical with such vasoconstrictors as ephedrine, amphetamine and epinephrine in counteracting the action of histamine on the bronchioles, and therefore the value of such salts in treatment of such conditions as allergic and surgical shock. When the radical was combined with calcium, histamine antagonism was well defined, as manifested by the degree of bronchiolar dilatation. The synergistic action of ascorbic acid with the radicals just mentioned offers many possibilities for active therapy if the substances can be proved as effective in the human body as in the experimental animal.

Parkinson [111] emphasizes the importance of the employment of nasal solutions comparable to the tissue fluids in tonicity and physical characteristics to avoid damage to the delicate tissue cells. He believes the situation is similar to the introduction of fluids via the intravenous or the intraspinal route. The solution employed should possess a p_H of 7.4 or a little above, since experience has shown that slightly hypertonic solutions are less irritating, having a tendency to draw off tissue fluids rather than to force the absorption of water beyond the ability of the tissue to pass it along. He also advises the use of sterile solutions and warns against the use of antiseptics.

Herzig [112] believes that the Dowling pack, when properly introduced with an isotonic, nonirritating silver salt and left in situ for at least fifteen minutes, is

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109. Howe, A. C.: Nucleic Acid Treatment of Subacute and Chronic Sinusitis, Ann. Otol., Rhin. & Laryng. **51**:220 (March) 1942.

110. Ruskin, S. L.: Influence of Vitamin C on the Antihistamine Action of Various Drugs, Arch. Otolaryng. **36**:853 (Dec.) 1942.

111. Parkinson, S. N.: Body Fluid as the Criterion for Solutions for Nasal Treatment, Ann. Otol., Rhin. & Laryng. **51**:153 (March) 1942.

112. Herzig, A. J.: The Colloidal Metallic Silver Tampon for Treatment of Rhinitis, Sinusitis, etc., Am. J. Surg. **56**:626 (June) 1942.

effective in relief of congestion and promotion of drainage. He prefers a colloidal suspension of metallic silver (colsargen).

Solis-Cohen [113] quotes Zinsser to the effect that "failure of chronic lesions to heal may be due to an insufficient supply of circulating antibodies or opsonic or bactericidal substances." On this theory he bases his claim to the efficacy of autogenous vaccines in the treatment of chronic sinus infections provided the vaccine is properly prepared and its efficacy has been tested by intradermal injections of various concentrations until the proper dose is arrived at. To determine the pathogenicity of the organisms it is necessary to grow them in the patient's own blood, since it is well known that "an animal often is able to remove from its blood stream germs that have gained access to it." He claims that the best test is the Cohen-Heist method, in which "a culture from an infected area . . . is planted simultaneously in a deep tube of rich culture medium, such as dextrose–brain broth, and in an empty sterile test tube into which several cubic centimeters of the patients' fresh, whole, coagulable blood is afterward placed." He cites several authors who have endorsed this procedure. The technic of administering the vaccine depends on the early determination of the minimum dose required to produce a local reaction. For this purpose he uses three concentrations of the blood-grown vaccine: the first containing 1: 50,000,000 organisms; the next, one tenth to one thousandth of this number, and the third, one tenth to one thousandth of the second concentration. Simultaneously, 0.05 cc. of the three solutions is injected intracutaneously into the forearm, and as a control a similar amount of vaccine prepared from broth-grown organisms. The dose is repeated at five day intervals and regulated according to the reaction. The author claims that the reason surgical treatment frequently fails is that the infective organism may still be present despite the removal of obviously diseased tissues and that therefore an agent which provides the body with proper and adequate antibodies will often succeed in cleaning up the residual and persisting infection.

De Macedo Leme and Whitaker [114] found that the staphylococcus was present in 80 per cent of a series of 80 cases of sinusitis. They collected 60 samples of Staphylococcus aureus, 10 samples of Staphylococcus citreus and 15 samples of Staphylococcus albus, all of which were cultured in order to produce a phage of high virulence. The details of the production of the phage are given according to d'Herelle's dictums. Of a series of 220 cases of acute sinusitis, the authors claim prompt relief of the symptoms in 124. The best results were obtained when the phage was introduced by a displacement method after thorough shrinking of the nasal mucosa and aspiration of secretions.

The Journal of the American Medical Association [115] reports that the following five alleged cures for asthma, hay fever and disorders of the sinuses have been barred from the mails by the Post Office Department: As-ma-norm, Dr. Hayle's method, minus-sinus, Orbert asthma treatment, Shackleton's inhaler and Shackleton's inhaler compound.

Displacement Therapy.—Glass [116] believes that the chief drawback to the original Proetz displacement treatment is the small amount of solution used. He proposes a method by which larger amounts of solution may be introduced into

113. Solis-Cohen, M.: Specific Vaccine Therapy in Treatment of Sinusitis, Arch. Otolaryng. **35**:623 (April) 1942.

114. de Macedo Leme, J. S., and Whitaker, J. G.: O bacteriophago nas sinusitis, Rev. brasil. de oto-rino-laring. **9**:456 (Nov.-Dec.) 1942.

115. Fraudulent "Cures" for Asthma, Hay Fever and Sinus Disorder, report of the Bureau of Investigation, J. A. M. A. **118**:317 (Jan. 24) 1942.

116. Glass, M.: Non-Surgical Sinus Drainage: A Prolonged Intermittent Technique, Clin Proc. **1**:177 (June) 1942.

the sinus, so that more irrigation as well as drainage is afforded. The procedure is as follows: The patient is placed on the side in something like the Parkinson position except that the head is rotated upward about 45 degrees and slightly backward so as to bring the ostiums of the posterior cells uppermost. A 16.6 per cent solution of ephedrine in isotonic solution of sodium chloride is instilled into the nostril that is dependent, and while suction is applied, an assistant instills several cubic centimeters of the solution into the uppermost nostril with each suction maneuver. In this manner 20 to 120 cc. may be used, and the treatment need be given only once weekly.

Siebers [117] reports excellent results in cases of acute sinusitis from conservative treatment consisting of displacement, hot fomentations of magnesium sulfate, inhalations of tincture of benzoin and salicylates. Displacement was practiced once or twice daily, and 28 out of 41 patients showed relief of symptoms after the first two or three treatments.

Roentgenographic and Physical Therapy.—Butler and Woolley,[118] reviewing their work of the past eleven years and the experience of other observers as to the value of roentgen rays in the treatment of chronic nasal sinusitis, conclude that this method of therapy has a definite place in the armamentarium and, so far as they have been able to determine, has never done a patient harm. They claim that the average for all published statistics shows that 33 per cent of the patients thus treated have been rendered symptom free, 41 per cent have improved and 26 per cent have not improved. Their dose is 300 r measured in air to each side, delivered by a 200 kilovolt machine through the equivalent of 0.75 mm. of copper and 3 mm. of aluminum at a distance of 50 cm. The treatment may be repeated in six to eight weeks if relief has not been complete. The authors describe and illustrate the lead masks which they employ to protect the adjoining areas, only the sinuses under treatment being exposed. They feel that the use of a single dose at one sitting is superior to treatment with divided doses, as formerly employed.

Van der Hoeve and van der Burg [119] reveal an extensive knowledge of American literature by their comprehensive references and their analysis of reports on the value of roentgen therapy of sinusitis. In their own experience, they have found roentgen rays of greatest value in treatment of the subacute type and of the chronic form, in which the pathologic process consists of simple hyperplasia without polyposis or fibrous tissue metaplasia. Roentgen therapy is also effective for children in whom the lymphatic elements of the nasopharynx, pharynx and cervical region are hyperplastic. Several illustrative cases are cited, together with the roentgenograms and microscopic slides demonstrating the pathologic processes frequently encountered. The authors appear to be in practical agreement with the generally accepted opinions on this side of the Atlantic regarding the limitations of roentgen therapy for sinusitis.

In a supplement to a previous communication on the roentgen therapy of acute sinusitis, Popp and Williams [120] confirm the good results obtained in the first series of cases by presenting a second series of 43 cases. They found the treatment

117. Siebers, B.: Acute Sinusitis, J. Christian M. A. **17**:145 (May) 1942.

118. Butler, F. E., and Woolley, I. M.: The Present Status of Roentgen Therapy in Chronic Paranasal Sinusitis, Radiology **39**:69 (July) 1942.

119. van der Hoeve, G. J., and van der Burg, L. W.: De Roentgenbehandeling van chronische ontstekingen der neusbijholten, Geneesk. tijdschr. v. Nederl.-Indië **81**:2289 (Oct. 28) 1941.

120. Popp, W. C., and Williams, H. L.: Roentgen Therapy for Acute Sinusitis, Radiology **38**:290 (March) 1942.

beneficial in 81 per cent of the second series, as compared with 62 per cent of the first series. The most striking benefit obtained was the relief of pain and headache, which was noted early in cases in which the results were favorable. The dose recommended is 50 r at each treatment for conditions of less than five days' duration and 75 to 100 r for conditions of longer standing. Treatments are given at a strength of 130 kilovolts with a 6 mm. aluminum filter (except in children, for whom a 4 mm. filter is used) and are repeated every second day for as many as three treatments in all. The authors state that this form of therapy must be considered complementary to the customary treatment.

Brighton, Snow and Friedman,[121] in analyzing the results of short wave therapy in 25 cases of acute and 110 cases of chronic sinusitis, conclude that this form of treatment possesses no advantages over the conventional conservative measures employed for acute sinusitis and has no value for allergic rhinitis. However, in cases of chronic sinusitis of the nonpurulent variety they found that short wave therapy affords considerable relief, especially from headache. They also comment on the fact that when used indiscriminately it may do harm.

Maxillary Sinus.—Dickson[122] describes his experiences with 263 patients whose antrums he had irrigated. The natural ostium was used in 58.8 per cent; puncture of the middle meatus was done in 31.3 per cent and puncture of the inferior meatus, in 9.9 per cent. He uses the Futch cannula, with which he finds it easy and safe to puncture the nasoantral wall through the middle meatus if the natural opening is not accessible. The inferior meatus is used only in cases in which an extremely deviated septum or the presence of polyps prevents access to the middle meatus.

Thorburn[123] stresses the importance of hygiene in the prevention and treatment of sinusitis and mentions such items as improvement in nasal respiration, proper attention to diet and fresh air. For acute conditions he advises rest in bed, proper elimination and ventilation of the nasal cavities. He decries douching and excessive use of drops and nebulizers.

Ethmoid and Sphenoid Sinuses.—Honiss[124] believes the majority of patients with uncomplicated infections of the ethmoid cells are better off under conservative measures, such as use of tampons, displacement therapy, removal of polyps and submucous resection of the septum. Radical surgical procedures are indicated only if chronic disease of the sinus is associated with involvement of the antrum and sphenoid or in the presence of allied disorders to which the ethmoid disease may be a contributing factor.

Tremble[125] discusses the various methods of locating the ostium of the sphenoid sinus and recommends a special blunt probe slightly bent at the end, with a marker on the handle indicating the average 7 cm. distance from the nasal spine to the surface of the sphenoid. This is placed in position and a roentgenogram taken for verification. The cannula, which has a flange near the tip to prevent too deep penetration within the sinus, is then passed and an attempt made to

121. Brighton, G. R.; Snow, W. B., and Friedman, H. S.: Short Wave Therapy in the Treatment of Sinusitis and Allergic Rhinitis, J. A. M. A. **118**:507 (Feb. 14) 1942.

122. Dickson, J. C.: The Use of the Middle Meatus in Antrum Lavage, Texas State J. Med. **37**:608 (Jan.) 1942.

123. Thorburn, I. B.: Treatment of Maxillary Sinusitis, M. Press **203**:73 (July 29) 1942.

124. Honiss, J. R.: The Treatment of Ethmoiditis, New York State J. Med. **42**:887 (May 1) 1942.

125. Tremble, G. E.: The Sphenoid Sinus: A Safe and Simple Method of Irrigation, Arch. Otolaryng. **35**:755 (May) 1942.

locate the ostium, which he states is on the average about 10 mm. from the roof and usually near the midline. If this maneuver fails, the cannula may be pressed through the anterior wall of the sphenoid sinus in the region of the ostium without much difficulty or danger.

CLINICAL OBSERVATIONS

General Considerations.—Looper [126] discusses the theories of the pathogenesis of the common cold, stressing mainly its infectious nature and the measures that should be taken in its prevention. The symptoms of acute sinusitis are given briefly and the usual means of diagnosis covered, with emphasis on the local findings and the value of roentgenograms, with or without contrast mediums. The author has not found transillumination of much value. He mentions having encountered 25 cases in recent years with marked cerebral manifestations in the early stages of acute infection of the sinuses in which the sinusitis cleared up promptly after proper drainage was instituted.

Bass,[127] discussing the etiologic significance of sinus disease in some general conditions, points out the importance of a careful history. Only by a proper evaluation of the sequence of symptoms and their development can one arrive at a proper understanding of the etiologic factors. Since the sinuses are frequently at the bottom of many disorders in organs some distance removed, it is important that all modern methods of diagnosis be employed and the results carefully studied before a conclusion is arrived at.

Wishart [128] presents a critical analysis of the relation of focal infection to disease of the sinuses and tonsils, which on the whole is rather pessimistic. He feels that the theory of such a relationship has not been satisfactorily explained and that in his experience it is not borne out by clinical observation. Despite the frequency of startling results in certain cases in which an infection cleared up after removal of a diseased focus in the nose or throat, he claims that definite conclusions cannot be drawn because of the frequent recurrence of the symptoms. He deplores the tendency to fads in medical therapy, which are quickly taken up by the public at large and which sooner or later are discredited because of their failure to prove the cure-all expected of them. It is therefore important that the prognosis be guarded in cases in which patent disease of the upper respiratory tract calls for surgical intervention and that the therapy be restricted to the pathologic process as elicited by careful diagnosis and history taking.

Spearman [129] covers the whole field of sinusitis, from anatomy to therapy, with particular emphasis on the diagnosis. He claims that "more sinusitis is diagnosed than exists" and states that, contrary to general belief, the diagnosis in many cases is difficult. He lists the numerous queries that should be put to the patient in obtaining the history and stresses the detailed care that should be taken in the examination. Also, he mentions the importance of assessment of the psychologic factors which may influence the picture. The article continues with a list of the various methods of treatment, medical and surgical, followed by a brief discussion of the chief complications that may be encountered.

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126. Looper, E. A.: The Diagnosis and Treatment of Upper Respiratory Diseases, North Carolina M. J. **3**:161 (April) 1942.

127. Bass, A. L.: Sinusitis and Its Relation to General Systemic Disease, Kentucky M. J. **40**:172 (May) 1942.

128. Wishart, D. E.: Focal Infection in the Nose and Throat, J. Michigan M. Soc. **41**: 478 (June) 1942.

129. Spearman, M. P.: Paranasal Sinusitis, Southwestern Med. **26**:332 (Oct.) 1942.

Heitger[130] vents his wrath on those who spread misinformation concerning sinus disease by word of mouth or via pseudoscientific articles in the lay press, whereby the gullible public is led into all sorts of misapplied therapy without regard for the pathologic condition that may at the moment be present. This tendency to empiricism, in his opinion, accounts for the pessimism expressed by many people with reference to sinus disease. He stresses the difficulties in diagnosis and the importance of accurate assessment of the degree of involvement of the sinus mucosa, since therapy can never be more than a hit or miss proposition unless it is based on knowledge of the true status within the sinus.

Rodger,[131] while stating that in most cases of chronic nasal catarrh the disease is due to involvement of one or more sinuses, emphasizes that in many instances the symptoms are the result of septal deformities which cause obstruction, irritation of the mucosa from the contact of spurs and crests with the turbinals and congestion due to impaired ventilation. He stresses the importance of careful diagnosis and describes the usual surgical procedures for the relief of various diseases of the sinuses and their complications. He believes that a carefully performed submucous resection, when indicated, will afford great relief in most instances, and he no longer resorts to postoperative packing, being content with swabbing the incision and surrounding mucosa with a preparation containing gum benzoin, 4 parts; styrax, 3 parts; tolu balsam, 1 part; ether, 40 parts, and iodoform, 10 per cent.

Van Alyea[132] reviews the most important contributions to the literature of nasal physiology, together with the pathologic observations, and offers suggestions as to therapy. He advises the use of a 0.5 per cent solution of ephedrine in isotonic solution of sodium chloride for vasoconstriction and the administration of infra-red rays and vitamin C in daily doses of 1 Gm. as the most effective treatment in the acute stages of rhinosinusitis.

Wynn[133] distinguishes between a primary cold, due to a specific filtrable virus, and a secondary cold, caused by ordinary bacteria. The former is much more contagious than the latter. The author believes that prophylaxis should begin early in childhood through strengthening of the resistance of cutaneous and mucous surfaces to vasomotor changes occasioned by changes in temperature and humidity. Also, he believes in the importance of general hygienic measures to prevent the spread of droplet infection, adequate ventilation of spaces where people congregate and segregation of patients taken with colds. He also feels that vaccines may be of value for persons subject to recurrent colds due to residual infection with bacterial agents.

St. Clair[134] would like to dispel the idea current among many of the laity that once a sinus is drained it remains permanently open and is therefore susceptible to disease. He finds this conception more prevalent among the so-called upper classes than among the lower wage earners.

Headache.—Buechner[135] classifies headaches of sinus origin into four types, namely: (1) headache due to obstruction without actual sinus infection; (2) headache due to sinus infection; (3) headache due to tumor, and (4) headache

130. Heitger, J. D.: Some Whys and Wherefores Relative to Nasal Sinus Histopathology, South. M. J. **35**:359 (April) 1942.
131. Rodger, T. R.: Chronic Nasal Catarrh, Practitioner **148**:82 (Feb.) 1942.
132. Van Alyea, P. E.: The Acute Nasal Infection, Nebraska M. J. **27**:265 (Aug.) 1942.
133. Wynn, W. H.: The Common Cold, Practitioner **148**:65 (Feb.) 1942.
134. St. Clair, C. T.: Sinuses, Virginia M. J. **69**:144 (March) 1942.
135. Buechner, H.: Headaches of Sinus Origin, J. Louisiana State Univ. School Med. **3**:6 (Aug.) 1942.

due to neuralgia. He states that headache due to sinus infection is not as frequent as is commonly supposed, occurring chiefly in acute conditions or in acute exacerbations of chronic conditions, and is localized within the region closest to the affected sinus or is transferred along the nerve pathways to distant areas. The headache of tumor origin usually does not manifest itself until the tumor causes obstruction to the ostium, invades the bone or is associated with an acute flare-up. The author discusses Sluder's syndrome and the syndrome described by Vail and mentions the necessity of investigation of the sphenoid sinus in cases of such conditions.

Ridges [136] deprecates the prevalent tendency among the laity and many of the medical profession of attributing all headache of undetermined origin to disease of the sinuses. He analyzes such common conditions as migraine, indurative headache and histamine headache and points out the characteristics of each and the modern accepted methods of therapy. When these conditions are excluded and the headache is definitely traced to a sinus it is not always necessary to carry out extensive surgical therapy. In cases of an acute condition results can be obtained by active shrinkage of the nasal mucosa, application of local heat and other conservative measures directed to drainage and ventilation. The author mentions recent reports of the success of roentgen therapy in cases of an acute condition and claims that equally good results can be obtained by the methods mentioned. In children particularly roentgen rays should be used with caution because of the danger to the ossification centers.

Ford [137] reports the occurrence of 2 cases of intractable headache over a period of years, in 1 of which relief was obtained by opening and draining the antrum and in the other by conservative treatment of the sinuses. In both cases the roentgenographic and local examination gave negative results.

Allergy.—Frackelton [138] believes that an allergic state may be prolonged through residual allergens' being locked up within the sinuses or trapped beneath the turbinates. Swelling of these bodies, resulting in prolonged contact with the septum, may cause the allergen to penetrate to the submucosa and produce sensitivity of the underlying periosteum and bone. He believes that postnasal irrigation with isotonic solution of sodium chloride enables the fluid to reach the nasal spaces not accessible to anterior irrigation, with removal of residual allergens. The same principle applies to the antrum, which should be washed out after an attack of nasal allergy or after the hay fever season. Also, the author recommends "allergy surgery" whenever it is indicated, so as to relieve the tissues from any pressure due to anatomic or pathologic changes. By "allergic surgery" he means the correction of a deviated septum, removal of spurs, trimming of hyperplastic turbinates, amputation of the anterior end of the middle turbinate or snaring off of the hyperplastic posterior end of the inferior turbinate. He claims that the freeing of the intranasal structures from the possibility of prolonged contact of mucous surfaces prevents intramucosal penetration, and when this is done in conjunction with the irrigation aforementioned, the possibility of absorption of allergens, as well as of secondary infective agents, is prevented and the remote effects so often seen in allergic patients are guarded against.

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136. Ridges, A. J.: Headache and Diseases of the Accessory Sinuses, Southwestern Med. **26**:291 (Sept.) 1942.

137. Ford, R.: Chronic Headache Caused by "Silent" Sinusitis, Brit. M. J. **2**:128 (Aug. 1) 1942.

138. Frackelton, R. J.: The Significance of the Nose in Allergic States, Ann. Otol., Rhin. & Laryng. **51**:626 (Sept.) 1942.

Riccitelli [139] is concerned with an analysis of the nature of allergy based on studies of the organism in its relation to the environment. After discussing the various manifestations of allergy, he considers their relation to the autonomic system, the endocrine glands, etc., and, finally, the influence of season and climate. He believes that cosmic and meteorologic conditions have a deep influence on physiobiologic processes through the changes in temperature, variations in the amount of actinic rays and the degree of static electricity in the air. All of these factors are more or less rhythmic in their changes, and therefore it may be expected that allergic persons will react correspondingly. He claims that spring is the season when hyperergic reactions are most manifest, and he adds that at this time the inorganic phosphorus and calcium contents of the blood are lowest. Therefore a study of the mineral metabolism is extremely important. He would like to know what connection there may be between the appearance of histamine and the changes in concentration of the various minerals in the blood and whether these changes may not be dependent on reactions within the skin following changes in atmospheric and solar conditions.

Luscher [140] attributes the allergic tendency to a hereditary hypersensitivity of the vegetative nervous system and a disturbance in the neurovegetative balance whereby the autonomic nervous apparatus affects the local reaction in tissues to various irritants. He feels that in cases of such hyperirritability there frequently may be an additional psychic factor which enhances the reaction. He cites the various stigmas so commonly existing in such cases and agrees that the presence of eosinophilia in the secretions and the tissues and blood is a valuable diagnostic sign. So far as sinus disorders are concerned, he finds that in many cases the presence of bacterial invaders complicates the picture, so that it is frequently difficult to determine which factor predominates. He agrees that secretions should be evacuated, polyps removed and other conservative measures employed until the allergic factor can be traced and eliminated before radical surgical intervention is resorted to.

Weille [141] finds that allergists cure about 20 per cent of their patients with asthma, relieve 60 per cent and fail to help 20 per cent. On the other hand, rhinologists cure about 10 per cent, relieve 40 per cent and fail to help 50 per cent. Since the factors in each case may differ, Weille believes that failure to recognize certain elements peculiar to each specialty contributes to the confusion and ineffectiveness of therapy. The best results are obtained through close cooperation between the rhinologist and the allergist. At least, each specialty should have a working knowledge of the other. Much depends on proper evaluation of both the extrinsic and the intrinsic factors with reference to degree, time of onset and variations with changing conditions. Vaccine therapy, often used as a last resort, is never of more than temporary value and should not be persisted in for more than one year.

Kuhn and Linton,[142] in a review of 720 consecutive cases of nasal disorders, found an allergic condition in 19.4 per cent; in 50 cases of this group the mucosa was tested, with demonstration of eosinophilia in one-half the number. In 40 per cent there was sensitivity to inhalants, in 5 per cent sensitivity to food or con-

139. Riccitelli, E.: Algunas cuestiones sobre las reacciones hiperérgicas de las mucosas nasal y paranasal, Rev. argent. de oto-rino-laring. **9**:139 (May-June) 1940.

140. Luscher, E.: Rhinopathia vasomotorica und verwandte neurovaskulare Storungen der nase und de nebenhöhlen, Schweiz. med. Wchnschr. **72**:432 (April 18) 1942.

141. Weille, F. L.: Fourteen Years of Practical Experience with Sinus Problems in an Allergy Clinic, Ann. Otol., Rhin. & Laryng. **51**:830 (Sept.) 1942.

142. Kuhn, H. A., and Linton, L. D.: Allergy in Relation to Otolaryngology, Ann. Otol., Rhin. & Laryng. **51**:162 (March) 1942.

tacts and in 54 per cent sensitivity to both foods and contacts. A review of the effects of treatment showed satisfactory results with allergic management alone in 47 per cent of the cases, with allergic treatment plus local therapy in 27 per cent and with allergic and surgical treatment in 21.7 per cent. Failures in treatment were recorded in 3.5 per cent. In diagnosis the authors depend on the history, the local findings and the character of the smears; the presence of 7 to 10 per cent of eosinophils is considered sufficient evidence of allergy. They found it necessary to resort to surgical measures in a larger percentage of cases than did Hansel, namely, in 20 per cent. They agree with the indicated procedures laid down by Dean: namely, submucous resection; cautery of the turbinates; scarification and use of escharotics for "tightening up" the turbinal mucosa; removal of polyps, adenoids and tonsils; drainage of infected sinuses, and ionization. They also found a number of cases in which endocrine deficiency was corrected with beneficial results, and they note that even in cases in which there was no demonstrable deficiency small doses of thyroid seemed to be helpful.

Shambaugh [143] noted eosinophils in abundance in the tissues in 40 per cent of a series of 300 cases of chronic sinusitis. He cites several illustrative cases in which rapid relief followed appropriate treatment for the offending allergen. He feels that in most cases of the purely infective type the condition is due to anaerobes, in many instances emanating from a dental focus.

Maxillary Sinus.—In a series of short articles, Denegri [144] discusses the various forms of chronic maxillary sinusitis, with differential points of diagnosis and suggestions for therapy. In the latent form, so frequently acting as a focus of infection, he finds displacement with opaque mediums and determination of the emptying time of value in diagnosis. The ostium of the sinus is usually blocked by swelling; the mucosa is uniformly thickened, and the emptying time is prolonged often as much as two to four days. In cases of this condition he recommends the Caldwell-Luc operation, with complete exenteration of the mucosa.

In contradistinction to the characteristic changes in the chronic form, in maxillary sinusitis of allergic type the ostium is patent and the mucosa uniformly thickened, but the emptying time is normal. In addition, the secretions contain eosinophils in abundance. These signs, together with the history and other evidences of allergy, should indicate the diagnosis. The treatment is well known. The only difficulty arises in cases in which secondary infection is superimposed on allergy, and in such cases both surgical treatment and an allergy regimen may be indicated.

Denegri describes a form of chronic sinusitis under the name "chronic serous maxillary sinusitis," in which the patient has attacks of profuse serous discharge accompanied by a stuffy nose, localized dull pains and tenderness. Transillumination and roentgenograms may show nothing abnormal, but contrast mediums reveal a thickened, irregular mucosa, often with polypoid formation. Histologic examination of the mucosa shows an edematous condition with irregular surface but no loss of superficial epithelium; in the deeper layers there is infiltration with lymphocytes and plasma cells. He claims this type of sinusitis is to be differentiated from simple hydrorrhea by the fact that with the latter there are no local symptoms, the discharge is bilateral and the symptoms appear in episodes, between which the patient is free from infection. The author recommends radical operation.

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143. Shambaugh, G. E., Jr.: Non-Operative Treatment of Acute and Chronic Sinus Disease, Proc. Interst. Postgrad. M. A. North America (1941), 1942, p. 180.

144. Denegri, J.: Las infecciones del seno maxilar y su tratamiento, Crón. méd., Lima **58**:257 (Sept.); 290 (Oct.); 381 (Dec.) 1941; **59**:35 (Jan.); 60 (Feb.) 1942.

Chronic catarrhal sinusitis is characterized by a mucoid or mucopurulent discharge, with or without nasal polyposis, and a sensation of weight or pressure in the forehead, and roentgenographic examination reveals a thickened, irregular mucosa. In this type of infection, also, the Caldwell-Luc operation is recommended.

The author offers nothing new concerning the purulent form of chronic maxillary sinusitis.

Segura and Murga [145] consider that the etiologic factors of maxillary sinusitis are of two types: first, factors arising from constitutional or hereditary predisposition and, second, acquired factors. They feel that idiopathic influences inherent in the organism predispose to the production of a thick mucosa, which tends to chronic hyperplastic types of infection, whereas other factors produce a thin mucosa, which tends to atrophic conditions. Also, they divide chronic sinusitis into the type which originates primarily in the antrum from acute infections of the upper respiratory tract and the type in which the antrum becomes involved secondarily from infection of adjacent structures, such as the teeth, or as a result of trauma. Also, they include constitutional diseases, such as diabetes, tuberculosis, syphilis and allergy, as contributing factors in both types.

Among the various diagnostic procedures they favor is the taking of a direct specimen for biopsy from the sinus mucosa via an inframeatal puncture made with a large trocar, a small Moritz Smith laryngeal forceps being used for obtaining tissue from the various recesses of the sinus. Histologic examination of these specimens will reveal the type and degree of severity of the pathologic process. They also have employed a physiologic test to determine the functional capacity of the lining mucosa. This is done by instilling a 5 per cent solution of azosulfamide and observing the rate of expulsion of the drug from the nose and its elimination in the urine. They found that normally the colored solution disappears from the nasal discharge in thirty-six hours. It first appears in the urine within thirty minutes, reaches its maximum in two to five hours and disappears in twelve to sixteen hours. In subjects with mild lesions of the sinus mucosa the solution disappears from the secretions in forty to eighty hours, appears in the urine within two to four hours and disappears within thirty-six hours. In subjects with degenerative lesions of the sinus mucosa the color may persist in the nasal discharge for eighty hours and may never appear in the urine.

The authors believe that constitutional therapy is of value in all cases of chronic sinusitis. They recommend a diet which tends to increase the amount of fixed calcium in the body and diminish the retention of fluids. For this purpose they suggests the use of dairy products, farina, rice, tapioca, reduced amounts of red meats, fish and other foods rich in iodine and poor in chlorine, a dietary regimen similar to that of Gerson and Sauerbruch. The diet should aim to produce a neutral reaction in the urine, and it should be rich in vitamin A. Furthermore, they feel that moderate doses of thyroid are beneficial in many cases in which the symptoms point to a mild deficiency. They employ a prescription consisting of 3.5 Gm. sodium sulfate, 3.5 Gm. sodium iodide, 1.5 Gm. sodium silicate and glycerin and water up to 60 cc., the dose being 1 teaspoonful in a glass of water daily.

Among various topical measures are displacement with mild protein silver and ephedrine and use of soluble sulfonamide compounds. They claim excellent results in some cases from the instillation of "cold" vaccine, "prontosil," sodium sulfathiazole and 10 per cent iodoform in glycerin.

145. Segura, E. V., and Murga, H. R.: Sinusitis maxilar crónica; sus indicaciones terapéuticas, Día méd. **14**:852 (Aug. 31) 1942.

Operative procedures, such as the Caldwell-Luc operation, are employed when conservative measures fail or the diagnostic measures indicate advanced degenerative changes in the mucosa.

Morse [146] had a patient aged 55 with severe nasal hemorrhages of undetermined origin whose condition was difficult to diagnose because of the evidence of previous operation on the nose, such as a nasoantral window and synechiae within the chambers. Despite frequent cauterizations and repeated packing, the hemorrhages persisted. After several months of treatment and observation, during which time dietary treatment and therapy with vitamins, calcium lactate, etc., was carried out, without much avail, a small granulomatous mass on the floor of the right nasal cavity and a similar mass in the ethmoid region were discovered. A small amount of intranasal radiation was given, supplemented by administration of a similar amount externally, the treatment being repeated later, with cessation of the bleeding. Histologic examination of material removed for biopsy some time after the irradiation revealed an adenomatous polyp, but the author believes that originally the mass was angiomatous and had changed under the influence of the radium.

Farrior [147] cites an interesting case of a boy of 13 years in whom, after acute rhinitis, there gradually developed a mucopurulent discharge, nasal obstruction and widening of the nasal bridge, due to the accumulation of caseous masses that filled the nasal chamber, pressing the septum to the opposite side and thus distending the nasal organ. A polypoid mass also appeared on the middle turbinate as a result of irritation. The patient was cured by frequent irrigations, which removed large amounts of caseous masses, and by an antrostomy, by means of which the antrum was irrigated. The cultures showed Str. viridans, Staph. albus and Micrococcus catarrhalis.

Cora Eliseht [148] would like to use the term "senitis," rather than "sinusitis," to indicate inflammation of the mucosa, preferring the Castilian root to the Latin. He discusses various anatomic points and classifies the pathologic states usually encountered in the antrum. Several histopathologic studies are presented.

Infections of Dental Origin: By "tooth antrum" Millhon and Williams [149] mean an infection of the antrum of dental origin. The case they report was confusing because of the presence of an infected unerupted third molar in a patient with a history of a residual first molar root on the same side from an extraction some years before. The treatment consisted of an operation exposing the alveolus, which revealed the fragment of root lying just beneath the mucosa of the antrum, whereas the third molar had eroded the buccal plate of the alveolus and infected the antrum. A subsequent antrostomy revealed a large cyst, which was removed *in toto*. Recovery was complete.

Koch [150] discusses several aspects of the relation of the teeth to infections of the antrum. He states that the presence of a tooth or root within the antrum does not necessarily mean that an infection will occur or the patient be aware of the anomaly. He cites cases in which such a foreign body was present for a long period without provoking any demonstrable reaction. However, he

146. Morse, S.: Hemangioma of the Antronasal Sinus Successfully Treated by Radium, Laryngoscope **52**:371 (May) 1942.

147. Farrior, J. B.: Rhinitis Caseosa, Arch. Otolaryng. **36**:725 (Nov.) 1942.

148. Cora Eliseht, F.: Senitis maxilar; concepto anátomopatológico, Rev. argent. de otorino-laring. **9**:25 (Jan.-Feb.) 1940.

149. Millhon, J. A., and Williams, H. L.: A So-Called Tooth Antrum in the Left Maxilla: Foreign Body in the Antrum and an Unerupted Third Molar; Report of a Case, Am. J. Orthodontics **28**:57 (Jan.) 1942.

150. Koch, J.: Das Verhalten der Kieferhöhle bei Erkrankungen der Zähne und nach operativen Eingriffen am Zahnsystem, Arch. f. Ohren-, Nasen- u. Kehlkopfh. **149**:317, 1941.

points out that as a rule the foreign body causes a local reaction and often becomes encysted. Symptoms will arise when the patient contracts an infection of the upper respiratory tract, which will sooner or later invade the sinus and find a nidus in the encysted foreign body. Frequently, this is the first notice the patient may have that something is wrong, and examination will lead to the diagnosis.

Hemorrhage into the antrum after extraction of a tooth may cause no harm providing the local treatment is restricted to the application of heat. Probing, suction or irrigation will surely lead to infection. The author cites several cases in which a "let-alone" policy resulted in complete absorption of the clot.

The presence of pus in the antrum does not necessarily constitute an indication for radical operation, since in many cases the antrum is acting merely as a reservoir and is not the seat of a generalized infection. In many of these cases the infection is localized to the portion of the alveolar recess immediately overlying an infected root, and this can be demonstrated by the use of contrast mediums. In such cases recovery will occur if the infected tooth is extracted and the local area given appropriate attention. When the infection has progressed to polyp formation, even though restricted to the alveolar recess, removal of the lining of the sinus is indicated. The author finds that disease of the antral floor frequently gives rise to neuralgic pains and tenderness over the antrum. He cites 5 cases in which, despite removal of the diseased tooth and the absence of pus in the sinus, instillation of a contrast medium revealed polyp formation in the floor of the antrum and the pain was finally relieved by radical operation.

The author cautions against one's jumping to the conclusion that the coincidence of infection of the antrum and the presence of diseased teeth necessarily indicates a direct relation. Generalized involvement of the entire sinus mucosa, especially when associated with infection of the ethmoid and frontal sinuses, usually excludes the teeth as a causative factor. Suspicion that the teeth are the real focus should be aroused when the contrast mediums reveal changes localized to the floor or the alveolar recess.

Henning [151] is concerned principally with infections of the antrum of dental origin, although, by way of comparison, he devotes considerable time to a discussion of rhinogenic antritis. Also, he poses a number of questions pertaining to the reasons for the development of various types of pathologic conditions encountered in the antrum, most of which he leaves unanswered. He claims that 47 per cent of all chronic infections of the antrum in his experience were of dental origin, and his analysis of the pathogenesis and symptoms recalls a similar investigation by Berry, which was abstracted in last year's review.[152]

The author points out that in most cases of infection of the antrum of dental origin there is little or no obstruction to the lumen of the ostium and the subjective symptoms are less pronounced than in cases of antritis of rhinogenic origin. Frequently, a discharge of foul odor is apparent only when the patient brings the head forward. The local signs may likewise be minimal. He finds a tendency to crusting and atrophy more frequent than hypertrophy. Irrigation of the antrum as a rule yielded a crumbly, fetid secretion. The author finds transillumination inadequate in diagnosis but stresses the importance of careful roentgenographic study. Such a study should reveal a chronic paradental pathologic condition, with

151. Henning, E.: Rhinogene und dentogene Entzündungen der Kieferhöhle, Ztschr. f. Stomatol. **39**:237 (April 11) 1941.

152. Berry, G.: Some Dental Observations by an Otolaryngologist, Ann. Otol., Rhin. & Laryng. **50**:995 (Dec.) 1941.

changes in the root of the tooth itself. It is not always necessary to demonstrate actual dissolution of the intervening bone between the tooth and the antrum, since it has been proved that the infection may be present without actual loss of bony structure. Besides, the infection is readily transmitted through the rich vascular system or by way of the lymphatics. Actual perforation of the antrum in the extraction of a tooth is practically always followed by infection of the sinus, and the author cautions against injudicious curetting of the tooth socket. Simultaneous involvement of the ethmoid and frontal sinuses is much less frequent in this form of antritis than in that of rhinogenic origin.

In the therapy of antritis of dental origin the author has seldom been able to achieve a cure by anything less than a Caldwell-Luc operation. He stresses the importance of making the nasoantral window sufficiently large and of thoroughly cleaning out the alveolar, ethmoid and prelacrimal recesses of the sinus.

Hall and Thomas[153] classify fractures resulting from dental extraction as follows: (1) penetration of the sinus alveolaris without rupture of the mucosa of the normal antrum; (2) penetration of the sinus alveolaris with rupture of the mucosa of the normal antrum; (3) penetration of the sinus alveolaris without rupture of the membrane of an infected sinus; (4) penetration of the sinus alveolaris with rupture of the mucosa of an infected antrum; (5) penetration into a sinus, either normal or diseased, with retention of a root or fragment of bone.

Further, they classify cases of such fractures into three groups: those in which the dental lacerations were closed and adequate nasal care was given; those in which the dental lacerations were closed but no nasal treatment was given, and those in which neither measure was carried out. In a series of 48 cases, the authors found residual alveolar fistulas in 19, in all of which sinus infection developed. In 12 cases the alveolar break was promptly closed and no nasal treatment given. In all these cases sinus infection developed. On the other hand, in 8 cases in which closure of the alveolar opening was immediately followed by adequate nasal therapy healing occurred without infection of the sinus. Also, in 24 cases the fistulas closed spontaneously and no nasal treatment was given, and in all of them sinus infection developed.

The conclusions from this experience are obvious.

Frontal and Sphenoid Sinuses.—Ruch[154] reports a case of hyperostosis in a pregnant woman, with a discussion of the feasibility of terminating the gestation. This was decided in the negative. Symptoms of pituitary disturbance had developed after the patient's first pregnancy, about seven years previously. This included headaches, mental depression and various characteristic physical stigmas. During a routine roentgenographic examination of the skull hyperostosis of the internal plate of the frontal bone was noted. The sinuses were normal, but the pituitary fossa showed some absorption of the posterior clinoid processes, suggesting a pituitary growth.

Andrews,[155] in discussing a case of hyperostosis frontalis interna, points out the importance of a correct diagnosis lest the patient be treated for something he does not have. His patient was at one time treated for hypoglycemia and once for diabetic coma. In another case to which he refers operation was performed for tumor of the brain. The features of the author's case were the narcoleptic attacks,

153. Hall, S. C., and Thomas, H. V.: Maxillary Sinusitis of Dental Fracture Origin, West Virginia M. J. **38**:146 (April) 1942.

154. Ruch, W. A.: Hyperostosis Frontalis Interna Accompanying Pregnancy—Case Report, Memphis M. J. **17**:195 (Oct.) 1942.

155. Andrews, C. T.: Hyperostosis Frontalis Interna, Brit. M. J. **2**:185 (Aug. 15) 1942.

which were controlled by amphetamine; increased dextrose tolerance; sudden gain in weight; restricted fields of vision; nerve deafness, and typical roentgenologic signs.

Samson, Caron and Martin [156] believe that heredity has something to do with the development of cranial dystrophies, such as hyperostosis frontalis, Paget's disease, hereditary dysostosis craniofacialis and leontiasis ossea, all of which are similar so far as they reflect a disorder of metabolism probably originating from endocrine dystrophy. They cite the case of a family in which the mother and 1 son had typical hyperostosis frontalis and 3 other children gave evidence of the disease to a lesser degree. The authors believe that the youth of the last 3 children accounts for the absence of a typical syndrome.

Gilbert [157] reports 5 cases of the Stewart-Morel syndrome, 3 involving women, and shows the roentgenograms, revealing the conspicuous changes in the bone, in 2 of the cases.

Peele and LeJeune,[158] in a study of a group of 75 patients with disease of the sphenoid sinus by means of direct instillation of various opaque mediums and roentgenograms, found hyperplastic sinusitis in 34 per cent, the hypertrophic form in 14 per cent and the suppurative form in 50 per cent. Allergy was a factor in all the types. The authors do not believe that the classic measurement from the nasal spine to the anterior wall of the sphenoid sinus is reliable; they prefer to measure from the columella to the posterior wall of the sinus. The average measurements were as follows: 9.29 cm. in the male; 8.9 cm. in the female, and between 8 and 12 cm., or about 8 cm., in children. A variety of radiopaque substances were used, without deleterious effect, and the resulting roentgenograms revealed a number of unusual conformations and extensions.

A wide variety of symptoms is discussed, including types of headache, referred ocular and aural symptoms and changes in the pharynx and the lower respiratory tract. They believe that sphenopalatine neuralgia due to sphenoiditis may originate either from the vidian or from the second division of the trigeminal nerve.

The treatment in the majority of the cases was direct lavage, displacement with solution of ephedrine sulfate and occasional instillation of radiopaque oil, which they found to have a distinct therapeutic value. A number of typical cases are cited.

AVIATION

Campbell [159] shows how rapid changes in barometric pressure, such as occur in the ascent or descent of airplanes, may produce symptoms referable to the sinuses. When the sinuses are normal these changes have little effect on function of the sinuses, but in the presence of fluid or obstruction about the ostiums function may be altered to such a degree as to give rise to severe symptoms. This condition the author terms "aerosinusitis," to conform to similar changes in the auditory apparatus long known as aero-otitis. Although no clinical conclusions are presented, it is clear that the prevention of disorders of the sinuses in aviators is dependent to a large degree on the maintenance of free middle meatuses by the elimination of obstructions of various kinds, as well as of abnormal secretions.

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156. Samson, M.; Caron, S., and Martin, C. A.: Syndrome d'hyperostose frontale interne á caractère familial, Laval méd. **7**:140 (March) 1942.

157. Gilbert, J. P.: Stewart-Morel Syndrome, or Syndrome of Internal Frontal Hyperostosis, J. Tennessee M. A. **35**:76 (May) 1942.

158. Peele, J. C., and LeJeune, F. E.: A Clinical Survey of the Sphenoid Sinus with Special Reference to the Direct Method of Lavage and Injection of Opaque Medium, Laryngoscope **52**:423 (June) 1942.

159. Campbell, P. A.: Aerosinusitis, Arch. Otolaryng. **35**:107 (Jan.) 1942.

In another contribution on the same subject, Campbell [160] elaborates further on the mechanism of the production of aerosinusitis when the mechanical conditions in the sinus, about its ostium and in the nasal cavity are such as to prevent free ingress and egress of air; under such conditions the balance of pressure may be disturbed, resulting in a train of symptoms, such as severe headache, dizziness, prolonged swelling of the mucosa and possibly hemorrhage.

Herrmann [161] cites 4 cases of aerosinusitis among fliers, who, after exposure to sudden changes in air pressure, complained of sharp pain in the forehead, cheek and eye, followed by a sensation of dull pain, which lasted for some time. Roentgenograms revealed separation of the mucosa within the antrum or the frontal sinus, which was circumscribed and which was considered due to a hemorrhage within the mucosa. The swellings disappeared within a few weeks, and the patients were able to resume flying.

In a subsequent contribution, the same author [162] claims that the condition is due to a suction effect within the sinus at a time when the ostium is closed, with prevention of equalization of air pressure on the two sides. He compares roentgenograms taken just before a flight, showing a normal frontal sinus, with pictures taken just after a flight, in which the separation of the mucosa is plainly visible, together with general cloudiness. In most of the cases the deformity is limited to one compartment of the sinus, which distinguishes it from the shadow due to hypertrophy or acute swelling. Also, the shadow seems to proceed from the periphery toward the center. The author has found that the occipitomental projection brings out the shadow much better than the occipitofrontal projection. The treatment outlined consists of measures to insure the patency of the ostium and applications of heat, short wave radiation or roentgen rays to hasten absorption. In only 1 case of frontal involvement was it necessary to open the sinus, although in the cases of antral disturbance he advises an early Caldwell-Luc operation, since it shortens the period that the aviator is incapacitated.

Bullwinkel [163] stresses the importance of normal nasal passages and patent ostiums of the sinuses to the well-being of the aviator. Equalization of pressure between the air within the pneumatic spaces of the skull and the outside air is necessary to prevent stasis and possible infection. These factors have been mentioned more and more frequently in recent literature, and flight surgeons are becoming acutely conscious of their importance. Also, it has been noted that unless complete restitution of the sinuses to normal is attained after acute infections of the respiratory tract, the flier is likely to become the victim of aero-otitis or aerosinusitis. The author discusses the care of these conditions.

Salem,[164] citing the investigations of Campbell and Armstrong on aerosinusitis, mentions 2 cases in which examination of the nose after descent from high altitudes revealed intense engorgement of the middle meatus on the side constricted by a high deviation of the septum. Submucous resection afforded relief. The author concludes, therefore, that high deviations of the septum may be a potent factor

160. Campbell, P. A.: Otolaryngological Problems of Aviation in World War II, Ann. Otol., Rhin. & Laryng. **51**:293 (March) 1942.

161. Herrmann, A.: Ueber Schleimhautablösungen und Hämatome in den Nasennebenhöhlen bei Fliegern, Ztschr. f. Hals-, Nasen- u. Ohrenh. **47**:103, 1940.

162. Herrmann, A.: Das Krankheitsbild der Schleimhautablösungen und der submukösen Hämatome in den Nasennebenhöhlen bei Sturzfliegen, Ztschr. f. Hals-, Nasen- u. Ohrenh. **48**:87, 1941.

163. Bullwinkel, H. G.: The Nasal Accessory Sinuses and Aviation Medicine, Mil. Surgeon **91**:522 (Nov.) 1942.

164. Salem, W.: Aerosinusitis, Hospital, Rio de Janeiro **22**:247 (Aug.) 1942.

in the production of persistent headache in fliers and that all fliers should be examined and treated for this condition before being permitted to ascend to high altitudes.

FRACTURES

Naftzger [165] describes the various types of fracture of the bones of the face and discusses the incidental involvement of the sinuses. Fracture of the malar bone in which the anterior wall of the antrum is involved is usually associated with fracture of the outer wall of the orbit and the infraorbital ridge. In cases of this injury it is often advisable to enter the antrum through a sublabial incision, with removal of particles of comminuted bone and replacement of the luxated malar bone and maxilla by intra-antral manipulation. Packing is not advised unless the infraorbital margin fails to hold in position. At times wiring may be necessary. The author does not advise subsequent irrigations, except after operation for the removal of clots.

Fractures of the ethmoid bone may involve the cribriform plate, with resultant emphysema of the orbit. Treatment which includes replacement of fragments should also include measures favoring drainage.

Fractures involving the frontal sinus may be treated conservatively unless the fracture is compound, in which case drainage is necessary.

Parker [166] describes three types of fractures of the maxilla based on the direction of the traumatic force: viz., fracture due to direct blow from in front or horizontally; fracture due to trauma from above, and fracture due to trauma delivered from the side. He states that a descending blow will usually fracture the nasal bones and cause a horizontal fracture of the maxilla into the antrum. In cases of such a fracture there is some hemorrhage into the sinus, and frequently external hematoma. Parker advises stereoscopic pictures, for better visualization of the lines of fracture and recommends early reposition of the fragments because of their early tendency to heal in a vicious position, with resultant external deformity.

Parker advises against disturbance of the primary blood clot and the avoidance of unnecessary manipulation of the parts. The usual methods of fixation of the fractured alveolar process, the body of the maxilla and the malar bone are described, with some personal modifications with which the author has been successful. The question of drainage of the sinuses when involved in fracture is not mentioned, although it frequently is of major importance.

Canfield,[167] in a brief article, touches on the high lights in therapy of injuries involving the nasal sinuses. He advocates exposure of the wound and closure of the fistula in cases of persistent rhinorrhea following fracture of the frontal sinus. While many patients respond to treatment with sulfonamide compounds, there is always the danger of meningitis, especially if the latent sinusitis becomes active.

Warren [168] describes fracture involving the zygomatic process, which is displaced inward and backward and is difficult to hold in place by any method other than that of wiring to an external appliance, a measure which frequently results in a scar on the face at the point where the wire emerges. He suggests the use of an inflated rubber bag within the antrum for one to three weeks. He claims that the

165. Naftzger, J. B.: Fractures of the Face Involving the Accessory Sinuses, Ann. Otol., Rhin. & Laryng. **51**:414 (June) 1942.

166. Parker, D. B.: Fractures of the Maxillary Bones, Laryngoscope **52**:365 (May) 1942.

167. Canfield, N.: Injuries to the Nose, Paranasal Sinuses, Mouth and Ears, Connecticut M. J. **6**:796 (Oct.) 1942.

168. Warren, E. D.: New Operation for Fracture of the Antrum, Dis. Eye, Ear, Nose & Throat **2**:304 (Oct.) 1942.

prior instillation of sulfathiazole or sulfadiazine powder prevents suppuration and a foul odor in most cases. The author has used this method in 6 cases, with excellent cosmetic results.

Orso [169] reports a case of fracture of the facial bones resulting from a fall. The patient was unconscious and bleeding from the nose. Examination revealed, among other things, a crack in the face of the sphenoid bone, about 2 to 3 mm. wide. The patient recovered.

Romney [170] reports a case of an open compound fracture of the frontal bone, with multiple fragments and loss of brain tissue. A successful result was obtained after débridement, disinfection and primary suture. The author exposed the entire frontotemporal area via a U-shaped incision over the zygoma and removed loose fragments of bone and some brain tissue that protruded through a laceration of the dura. The bony fragments were placed in warm sterile physiologic serum and later used to build up the outline of the bone. Roentgenograms show complete regeneration of bone, with good cosmetic results.

MISCELLANEOUS

Silvers,[171] who has previously contributed articles to *Hygeia* on hygiene in swimming, adds a few notes of caution for the benefit of lay readers with regard to the importance of keeping the water out of the nasal cavities. When one is swimming with the head under water, he should exhale, and when he is diving he should close the nostrils. One cannot entirely agree with his statement that "those unfortunate enough to have ear and sinus involvements need not be kept from enjoying the refreshing and tonic effect of bathing outdoors in hot weather if these precautionary measures are observed."

Cawston [172] is opposed to the use of nasal irrigation except for the removal of thick secretions. He believes that in many cases of infection of the antrum the process has spread from an undiscovered infection of a tooth. In some cases the sinus disease is not manifest, the patient complaining of remote, apparently unrelated symptoms, such as tinnitus, fatigue on exertion and postnasal discharge. Such symptoms should lead to an investigation of the sinuses, and the author is convinced that in many instances infection of the upper molars is the primary etiologic factor.

25 East Washington Street.

169. Orso, L.: Injuries of Sphenoid Sinus, Orvosi hetil. **85**:467 (Aug. 30) 1941.

170. Romney, H.: Fractura abierta del frontal con pérdida de sustancia cerebral desinfección quirúrgica seguida de sutura primitiva sin drenaje, Rev. san. mil., Habana **6**:43 (Jan.-March) 1942.

171. Silvers, L. J.: Swimming Safely, Hygeia **20**:508 (July) 1942.

172. Cawston, F. G.: Pan-Sinusitis in the Sub-Tropics, J. Trop. Med. **45**:73 (May 15) 1942.

Abstracts from Current Literature

Pharynx

AN OUTBREAK OF STREPTOCOCCIC SEPTIC SORE THROAT IN A CAMP. A. L. BLOOMFIELD and LOWELL A. RANTZ, J. A. M. A. **121**:315 (Jan. 30) 1943.

The authors report 341 cases of septic sore throat, discussing in moderate detail the incidence, clinical features, sequelae, bacteriologic observations and clinical interpretations and the relation of the clinical picture to persistence of streptococci in the tonsils during convalescence. The mass infection was due to hemolytic streptococcus Griffith type 15. Milk was ruled out as the source of infection. There were no complications and no deaths.

Therapy consisted of rest in bed, general measures and administration of sulfonamide compounds. No definite conclusions could be drawn as to the efficacy of these compounds.

GORDON, Philadelphia.

ROENTGEN THERAPY FOR CHRONIC INFECTIONS OF THE LYMPHOID RING OF WALDEYER. J. J. REBOIRAS, J. E. MOREAU and M. H. MOREAU, Arch. argent. de pediat. **16**:339 (Oct.) 1941.

The authors believe that roentgen treatment for hypertrophy and infection of the ring of Waldeyer offers a painless therapeutic measure which is certain, efficacious and harmless. The use of roentgen therapy does not contraindicate later surgical intervention. Roentgen therapy can be begun with the child even younger than in the fourth year. Roentgen therapy is always indicated if surgical measures have been ineffectively used.

SCHLUTZ, Chicago [AM. J. DIS. CHILD.].

FATAL DISSEMINATION IN A TUBERCULOUS PATIENT FOLLOWING TONSILLECTOMY. GARCIA ALVAREZ and CESAR RODRIGUEZ, Arch. venezol. de Soc. de oto-rino-laring., oftal., neurol. **3**:136, 1942.

The authors present the case of a patient who was admitted to the hospital with active tuberculosis. Pneumothorax therapy was instituted, and finally phrenicotomy was performed. In general the patient responded well, but he was troubled with a chronic infection of the upper respiratory tract. Since the temperature was normal, the sputum was negative and the general physical condition appeared excellent, a tonsillectomy was performed prior to discharge from the hospital, and three months after the phrenicotomy. There were no immediate complications, and biopsy of the tonsil revealed chronic tonsillitis with hypertrophy.

However, twenty-five days after the tonsillectomy, the patient became extremely toxic and febrile and complained of pain in the left pleura, complete aphonia and dysphagia. He presented extensive dissemination of the tuberculous process throughout all organs of the body and died two months later.

PERSKY, Philadelphia.

Larynx

POSTDIPHTHERITIC LARYNGEAL STENOSIS. SIMON JESBERG, J. A. M. A. **120**:1000 (Nov. 28) 1942.

The author discusses his observations on the management of postdiphtheritic laryngeal stenosis in a series of 108 patients who were referred to his service.

He emphasizes the value of protracted treatment with some dilating device introduced into the larynx, and he finds soft rubber in the form of tubing or core molds the best substance for this purpose. Thus, a minimum of injury is produced; at the same time continuous gentle, but firm, pressure is exerted on the larynx.

The method by which the rubber sections are made, cut and beveled at both ends and marked, and the technic of introduction into the larynx through a small tracheal stoma or through a tracheotomy wound are fully discussed.

The period these rubber sections are left in place is important. They must not be changed too frequently or too seldom. The best results are obtained when the section is changed every three weeks.

GORDON, Philadelphia.

A Plastic Procedure for Correction of Laryngeotracheal Stenosis by Means of a Dermoepidermal Graft. M. Rapin, Pract. oto-rhino-laryng. **4**:88, 1942.

Rapin has employed the following technic in the correction of laryngeotracheal stenosis. He performs a laryngofissure, through which he excises and frees all adhesions. Then he prepares a Thiersch skin graft from either the anterior surface of the thigh or the inner surface of the arm. This graft is placed on a piece of soft rubber tubing, with the raw surface outward and the edges sewn together with fine catgut. The lumen of the rubber tube is filled with sponge rubber and attached to a long string. This graft-covered tubing is inserted into the laryngeal passages, and the external wound is closed. Eight to fourteen days later the rubber sponge is extracted by pulling the attached string from the mouth. The rubber tubing is also extracted in a similar manner.

This procedure appears to solve the difficulty that Rapin encountered in his previous cases, in which the graft failed to "take."

Persky, Philadelphia.

Nose

The Significance of the Nose in Allergic States. Ralph J. Frackelton, Ann. Otol., Rhin. & Laryng. **51**:626 (Sept.) 1942.

The author briefly discusses allergy and immunity. Tissue in an allergic state is often more susceptible to infection than is normal tissue unless it has acquired some degree of immunity independent of the allergic state. Although bacteria may invade the body anywhere, the nose and the gastrointestinal tract are potential points of entry for undigested proteins. From the postnasal drippings the gastrointestinal and respiratory tracts receive the secondary products of reactions to bacteria and inhalants present in the nose. Allergic reactions and those concerned with immunity do not necessarily run parallel; they may exist together, or they may be independent. Every allergic manifestation that is associated with sufficient mucosal swelling is accompanied by new inoculation with the undigested protein. If the allergic swelling is kept in abeyance long enough, the patient will be relieved of repeated inoculations incident to the allergic reaction. As the stimulation lessens, hypersensitivity may subside. The therapeutic regimen for the allergic state is most practical when it provides for the withdrawal of the offending allergens of foods, inhalants, physical agents and bacteria and at the same time increases antibacterial immunity by the use of stock and autogenous vaccines, vitamins and endocrine preparations and by the supply of necessary nutritional factors. So-called desensitization by administration of allergen is merely an adjunct to the regimen.

It is pointed out that certain anatomic abnormalities of the nose produce contact points between mucous surfaces which may imprison inhaled substances between them, from which this material is actually carried by leukocytes to the reticuloendothelial system of the tunica propria. Because of this possibility, the author advocates removal of spurs, correction of septal deflections and reduction in size of, or removal of, enlarged turbinates. He also points out that at times inhaled pollens are caught in sinus cavities and may, if not removed, hold sufficient foreign material to keep up the inflammatory process for years. After the hay fever season, he advocates bilateral irrigation of the antrum in cases of allergy to eliminate the pollen and mucus incident to the attack. The author's method of prolonged postnasal irrigation is described; he feels that with this method much material which would otherwise cause prolonged trouble is washed away. A number of cases are cited in proof of various points.

M. V. Miller, Philadelphia.

Rhinogenic Optic Neuritis and Oculo-Orbital Complications of Sinusites. R. Argañaraz, Arch. de oftal. de Buenos Aires **16**:541 (Oct.) 1941.

The intimate anatomic relations of the orbit with the neighboring nasal cavities are stressed, as well as the likelihood of infection from these cavities not only of the cellular tissue of the orbit but of the membranes of the eyeball and its neurosensorial apparatus.

Argañaraz classifies the ophthalmic complications of sinus trouble into (1) an anterior frontal-ethmoid-maxillary group and (2) a posterior sphenoid-ethmoid group. It is well, however, to remember that only rarely is a single sinus affected, monosinusitis being the exception and polysinusitis the rule.

The first group comprises: (1) orbital cellulitis and abscess, (2) iritis and iridocyclitis and (3) oculomotor and sensory palsies. Orbital cellulitis and abscess are always of secondary origin and are due mostly to the streptococcus and less frequently to the pneumococcus or the staphylococcus. When the cause is a thrombosis of the cavernous sinus, the outcome is usually fatal, with rapid involvement of the optic nerve and its sheaths and destruction of vision.

A consideration of the second group of ophthalmic complications constitutes the major part of the article. Their origin from ethmoid and sphenoid sinusitis is readily explained by

the intimate relations of the optic nerve in its intracranial portion with the sphenoid sinus and the posterior ethmoid cells.

The originating sinus trouble is usually a part of general polysinusitis and may exist in a latent form. The visual symptoms are often the first to demand attention. A roentgen examination is required but at times gives negative results. The extension to the optic nerve and its sheath is generally direct, but occasionally it is through venous anastomosis. Reference is made to cases in which no inflammatory signs are apparent but in which the visual symptoms improve on opening of the sinus or on application of cocaine and epinephrine hydrochloride or of amphetamine. The functional disturbances in these cases are explained on the basis of changes in the sympathetic innervation of the blood vessels. Some varieties of retrobulbar neuritis are attributed to opticochiasmatic arachnoiditis. In the optic nerve the maculopapillary bundle of fibers is often affected.

Clinically, the onset of retrobulbar neuritis is most often acute and unilateral, with the production of a central scotoma of from 20 to 50 degrees. The disease generally lasts two to three weeks, disappearing gradually on improvement of the rhinitis. Subacute forms also occur, with a scotoma of from 10 to 20 degrees. There is an accompanying increase in the size of the blindspot. As a rule there are no ophthalmoscopic signs at first. If the process is intense and of long duration, pallor and finally optic nerve atrophy are apt to occur.

The differential diagnosis is concerned with the retrobulbar neuritis of multiple sclerosis, with that of opticochiasmatic arachnoiditis and with the toxic form.

Many cases terminate favorably with medical and local treatment, the latter consisting of applications of cocaine and epinephrine hydrochloride to the nose in the proximity of the opening of the sphenoid sinus. If any general catarrhal symptoms are present, they must be attended to. When these simple measures give no relief, surgical opening of the sphenoid sinus must be resorted to.

FINLAY, Habana, Cuba [ARCH. OPHTH.].

TRANSITORY AMAUROSIS FOLLOWING LOCAL ANESTHESIA OF THE NASAL SEPTUM. ARISTIDES MONTEIRO, Arch. venezol. de Soc. de oto-rino-laring., oftal., neurol. **3**:107, 1942.

Monteiro describes a case of amaurosis which occurred while he was anesthetizing the nasal mucosa preparatory to doing a submucous resection. In his technic he injected a few drops of a 1 per cent solution of procaine hydrochloride (with epinephrine) into the mucosa, in the vicinity of the anterior ethmoid nerve. Immediately after this injection the patient complained that everything appeared blurred, and shortly thereafter he became totally blind. The pupils were widely dilated, but no other symptoms were noted. However, after a few minutes, the author completed the operation. The patient began to see light shortly thereafter, and vision returned completely. The entire episode lasted twenty minutes. The author believes that a few drops of the procaine entered the anterior ethmoid artery and reached the retinal artery, and so produced the amaurosis.

PERSKY, Philadelphia.

Miscellaneous

HEADACHES. PAUL MAHONEY and J. S. AGAR, South. M. J. **34**:956 (Sept.) 1941.

In discussing headache, the authors state that sinus disease is an infrequent cause of chronic headache. In diagnosis of the cause of headache, they believe much can be learned by carefully observing the patient's attitude, posture, facial expressions and the manner in which he relates his problem. They also stress the importance of a careful history, including data on the patient's age, occupation and living habits.

Headaches resulting from high deviations of the septum, acute and chronic sphenoiditis, acute and chronic frontal sinusitis, chronic ethmoiditis, trigeminal neuralgia, neuralgia referable to the sphenopalatine ganglion, menstrual disturbances, syphilitic infection, malocclusion of the teeth, dental infections, psychic factors and occupational factors are discussed briefly. The article is concluded with an outline for use in diagnosis of the cause of headache.

SINGLETON, Dallas, Texas.

THE ETIOLOGY OF GANGRENE ASSOCIATED WITH DEEP INFECTIONS OF THE NECK. CHARLES D. BLASSINGAME, South. M. J. **34**:1121 (Nov.) 1941.

The author states that deep infections of the neck originate from the dental areas, the pharynx and the sinuses and ears. Infections from the dental areas are mixed and are likely to present anaerobic characteristics. Infections extending from the pharynx are most often due to the hemolytic streptococcus. Infections arising from the sinuses and ears may be due to the staphylococcus, the pneumococcus or the streptococcus or to any combination of these three organisms.

Infections from these sources may extend into the lateral pharyngeal space, the submaxillary space, the parotid space, the retropharyngeal space, the visceral space and the carotid sheath. Until recently the type and the cultural characteristics of the infecting organism have not greatly influenced the diagnosis and treatment of deep infections of the neck. However, since Melney has shown that the microaerophilic hemolytic streptococcus produces extensive necrosis and grows best under reduced oxygen tension, it has been found that infection due to this organism responds most favorably when oxidizing agents are used in treatment. The author reports in considerable detail a case of an infection which probably belongs in this category. Other types of gangrene due to infections and vascular changes are discussed briefly.

SINGLETON, Dallas, Texas.

THE CORRECTION OF DISORDERS OF SPEECH. T. EARL JOHNSON, South. M. J. **34**:1143 (Nov.) 1941.

The disorders of speech are classed as phonatory and articulatory. The various types of dysphonias are usually due to disorders of pitch, intensity and quality. The articulatory disorders are due to structural deformities of the mouth, nasal obstructions and impaired hearing. Since vigorous vocal exercises may cause much harm to a patient suffering from an active disease of the larynx, a thorough medical examination of the patient should be made prior to any corrective speech training for phonatory disorders.

In articulatory disorders of speech due to deformities and obstructions, one should correct the deformity early, preferably before the patient has learned to talk. If speech has been acquired before surgical repair is made, a definite program for speech rehabilitation is essential, especially in a case in which the difficulty is due to a cleft palate. When speech defects are due to a hearing loss, audiograms should be taken to determine the exact loss of hearing, and the patient should be provided with a proper hearing aid, "tailor made" to fit his needs.

SINGLETON, Dallas, Texas.

RHEUMATISM IN CHILDHOOD AND ADOLESCENCE. P. KUTUMBIAH, Indian J. Pediat. **8**:203 (Oct.) 1941.

Rheumatic fever should be considered as a disease of the heart, with arthritis and chorea in the nature of complications. There is no satisfactory explanation of the increased vulnerability of the juvenile heart, but it is probably linked up with the greater vascularity of the valves. Vining expressed the belief that a nutritional defect, especially a vitamin B deficiency, prepares the soil for rheumatic infection. However, such failures of health are common to many diseases of childhood and may well be due to the rheumatic infection itself. While frank vitamin B deficiencies are fairly common in India, they do not occur at the age of susceptibility to rheumatic fever. It is probable that subclinical deficiencies of vitamin C are common in India, as well as in western countries, but there is no proof of any relation to rheumatic infeetion. Tonsillar infection is believed to be extremely important, as only 1 of 457 patients with rheumatic fever had had the tonsils removed prior to the initial infection. Of associated diseases, ancylostomiasis, congenital syphilis and herpes zoster were the most common. Arthritis, either previously, or on admission, was found in 68 per cent. In order of frequency the joints affected were the knee, ankle, hip, elbow, wrist, shoulder and those of the great toe and neck. Rheumatic infection affects all structures of the heart, but not to an equal degree. Acute, fatal pancarditis is rare in India. Mitral stenosis with regurgitation is the most common valvular lesion. Rheumatic nodules are rare. Chorea is said to be rare in India, but the author believes it is fairly common. Arrhythmias are uncommon. Pulmonary congestion, bronchopneumonia and pleurisy were found in several cases. Relapses occurred in 37 per cent. Sedimentation rates were regularly rapid. Nonhemolytic streptococci were found three times on culture of the blood.

TENNEY, Madison, Wis. [AM. J. DIS. CHILD.].

A GENERAL SURVEY OF OTORHINOLOGICAL CONSIDERATIONS IN SERVICE AVIATION. J. F. SIMPSON, J. Laryng. & Otol. **57**:1 (Jan.) 1942.

The organ which is perhaps most commonly affected by flying is the ear. The first deleterious effect of aviation was experienced in 1783, during one of the earliest balloon flights ever made.

The noise of modern aircraft is immense and is responsible for the problem of noise deafness in aviation. Since telecommunication in planes and between them and the ground has been greatly extended in recent times, the importance of good hearing in flying personnel is obvious, especially when it is remembered that messages must often be heard under most difficult circumstances.

The usual hearing tests cannot be regarded as entirely satisfactory, and the results are not comparable. The results of the whisper test vary too widely, and pure tone audiometry is too time consuming for routine purposes; furthermore, no clue to the quickness of interpretation is taken into consideration. An attempt to find a practical, but accurate, method of grading the ability to hear speech is now being worked on by squadron leader Fry, of the department of phonetics at University College, London.

The commonest, and most dramatic, disorder of the ear and nose is caused by disturbances in altitude. These disturbances depend on changes in barometric pressure, and not on lack of oxygen. With changes in altitude, air will flow in or out of the middle ear and sinuses, so that the pressure within them and that of the external atmosphere are equalized. Obstruction to this equalizing mechanism gives rise to the painful complaints met with in aviation.

The middle ear and the sinuses should be regarded as rigid bony cavities lined with mucous membrane and having small openings to the external air. In the case of the middle ear, however, there is the elastic drum head, which bulges inward or outward, according to the difference of pressure on the two sides. Pain in the ear or sinuses may be mild or so severe as to incapacitate the airman.

Experiments indicate that pain in the ears or sinuses is due to changes in the mucous membrane. Congestion, as demonstrated by hemotympanum or hematocele of the antrum, occurs, but it is probable that more complex factors are responsible for the pain. Occasionally a severe form of permanent nerve deafness may develop from flying. Two cases, both the result of power diving, are recorded.

Besides alteration in altitude, the ear is affected by changes in speed, direction and position in aviation. The development of blind flying has reduced the importance of these factors, but "flying sense," which is acquired by experience, is still necessary. In practice, routine rotation tests give little information in determining flyers who will or those who will not suffer from air sickness.

Disease of the ear, nose or throat will impair the efficiency of the aviator. Active suppuration of the ear is regarded as a contraindication to flying. A dry perforation usually means deficient hearing and a chance that otorrhea will recur. Provided there is no appreciable loss of hearing and the eustachian tube is easily opened, a moderate degree of scarring of the drum membrane does not debar the candidate from flying. Any evidence of past suppuration should arouse suspicion that the eustachian tube may be left with some dysfunction, and it is notable that among sufferers from aero-otitis a fairly large proportion have a history of otitis media. Since all acute inflammatory conditions of the nose and throat may interfere with the mechanism for adjusting pressure in the ears or sinuses, flying with a sore throat or cold in the head is forbidden. Chronic infections are regarded seriously, but the effect is less easy to forecast. Deflections of the septum are not operated on unless definite obstruction and discomfort are present.

LeJeune and Bayon, New Orleans.

Discussion of Injuries of the Nose and Throat. V. E. Negus and others, Proc. Roy. Soc. Med. **35**:513 (June) 1942.

Negus stated that of the patients with injury to the head admitted to the Horton Emergency Hospital, just over one-half had a craniocerebral lesion. The nose and sinuses suffered relatively infrequently and the pharynx and larynx scarcely at all. For hematoma of the septum Negus advised free incision and evacuation. For fracture of the nose with displacement he used a splint made of successive strips of broad ribbon gauze to which collodion is applied. The effusion of blood into a sinus is better left alone. Simple fractures of the walls of the sinuses may not call for treatment, except in special instances. Depression of the lacrimal bone may lead to obstruction of the nasofrontal duct. Compound fractures into the sinuses will require closure, and perhaps manipulation of the fragments, so that functional restoration and proper cosmetic effect can be obtained.

Wounds of the pharynx are rare because of the fatal result produced in most cases by projectiles penetrating the neck. If a patient survives, infection of the parapharyngeal space may develop.

The larynx may become involved by bruising of the vagus nerve or one or both recurrent laryngeal nerves. Fracture of the thyroid cartilage is not serious, but fracture of the cricoid cartilage is dangerous because of subsequent obstruction to breathing. A penetrating wound of the larynx or trachea and the establishment of a fistula between the larynx and the esophagus occasionally occur.

Kilner stated that few surgeons are sufficiently radical in dealing with simple fractures of the nasal bones. Free disimpaction and mobilization are essential. No restoration of contour in the region of the frontal sinus should be undertaken for at least six months after all discharge has ceased. Many penetrating wounds of the maxillary sinus close

spontaneously, but usually with depressed scars. It is possible to restore contour by excising the adherent scars and building out the depression by local flaps of deep tissue. Fracture in the malar and zygomatic regions is frequently overlooked. They should be promptly corrected. In cases of loss of the nose structure skin grafts and forehead flaps are necessary for correction.

Simpson said that fracture of the nose often produced obstruction of the nasolacrimal duct.

Davis was convinced that the injuries of the nose and throat should be treated within the first twelve hours by restoration of as normal condition as possible.

Other discussers gave various opinions on the principles and methods of correcting the deformities incident to injuries of the nose and sinuses.

CAMPBELL, Philadelphia.

DIFFUSE MENINGOENCEPHALITIS (TRAUMATIC) DUE TO HAEMOPHILUS INFLUENZA. OSCAR BARRERO and AURELIO HERNANDEZ, Medica **1**:53 (March-April) 1942.

Barrero and Hernandez present a case. An 18 year old youth was injured in the face in an explosion of a mechanical apparatus. There was a deep laceration of the skin over the frontal sinus, with hemorrhage and fracture of the bones of the nose, the nasal spine of the frontal bone, the inferior portion of the perpendicular plate of the ethmoid bone and the floor of both frontal sinuses. The left eye was also injured in its lower anterior pole, with total enucleation of the eye. There was a fracture in the superior maxilla, which separated the hard palate from the rest of the maxilla.

Six days after his preliminary first aid treatment and the reduction of the fractures, to which he apparently responded favorably, the youth began to manifest signs of cerebral irritation, with elevation of temperature and some nuchal rigidity. A spinal puncture revealed fluid under moderate hypertension, containing 1,025 leukocytes. Subsequent culture of the spinal fluid revealed Haemophilus influenzae. Sulfanilamide therapy was instituted. After a rather stormy convalescence, during which he was treated by repeated lumbar punctures, intensive use of sulfanilamide and its derivatives, blood transfusions and injections of hypertonic dextrose solution, the patient eventually recovered.

The points stressed in this presentation were the extensive injuries complicated by meningoencephalitis due to Haemophilus influenzae, the value of intensive medication as outlined in the article and the need for early diagnosis so as to anticipate the formation of encapsulated microabscesses at the base of the brain.

PERSKY, Philadelphia.

Society Transactions

COLLEGE OF PHYSICIANS OF PHILADELPHIA, SECTION ON OTOLARYNGOLOGY, AND PHILADELPHIA LARYNGOLOGICAL SOCIETY

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Regular Meeting, March 17, 1943

Osteoradionecrosis and Cancer of the Head and Neck. MAJOR MARSHALL B. STEWART, Medical Corps, Army of the United States (by invitation).

Osteoradionecrosis is almost unknown to the medical profession in general. It is caused by roentgen or radium therapy together with other factors, which will be discussed later. Since the advent of high voltage ("deep") roentgen ray therapy for the treatment of cancer and other diseases, osteoradionecrosis is more prevalent than one might be led to believe. The term osteoradionecrosis was first used by the French author Nageotte.

In reviewing the literature, both domestic and foreign, one finds that only six specific articles have been written on this subject in the United States and Canada. The reports in foreign literature exceed that number by only a small margin. Most of the papers are reports of isolated cases. Although dentists do not include roentgen or radium therapy in their armamentarium, they are usually the first to recognize and report osteoradionecrosis. Notable also are the contributions to medical literature made by the radiologists. The largest series of cases to date have been collected and published by Watson and Scarborough, but up to the present time little effort has been made to bring this morbid complication to the attention of physicians in general.

Necrosis of the jaws is produced by several causative agents; among them are roentgen rays, radium, arsenic, phosphorus and thorium.

Cellular Reaction to Irradiation.—The effects of radiation on the formed elements of the blood were studied by Kornblum, Boerner and Henderson. These investigators found that leukocytes and platelets showed the greatest amount of reduction. Roentgen radiation and radium have only a minor effect on red blood cells and hemoglobin, which are reduced in some cases. This reduction was believed to be due to depression of the hemopoietic system. Reduction in the cellular elements of the blood was not due to cellular disintegration. All the cells produced were normal. Ordinarily roentgen therapy is seldom withheld because of its effect on leukocytes and platelets except in the blood dyscrasias. The aforementioned authors did not make experiments with high voltage rays. The same authors in additional work found that about five weeks was required for the leukocytes to return to their normal level. If the count does not become normal in eight weeks, the prognosis is unfavorable.

Changes Following Irradiation of Bone.—The bones of the head most frequently altered when irradiated are first the mandible, second the maxilla and last the bones of the calvarium. The maxilla has a better blood supply than the mandible and is more fortunate than its neighbors except for housing the roots of the upper teeth. The mandible, because of its ribbon-like shape, its compact composition and the presence of but a single nutrient artery on each side, is more susceptible to the effects of radiation than any other bone in the head. No other bone in the body has such a dense structure with the possible exception of the neck of the femur. Both of these bones with potential poor circulation are subject to delayed union when fractured, and they are also subject to necrosis when irradiated. Bone receives its greater portion of nourishment from the periosteum and from nutrient arteries situated around the ends of long bones supplied by the capsular arteries; the marrow also aids in bone nutrition. The branches of the haversian system are enclosed by bone lamellas in which are found lacunas containing bone cells. The lacunas intercommunicate through fine canaliculi.

The mineral content of bone is 85 per cent calcium phosphate, which has an atomic weight of 40. According to Ewing, calcium produces an unusual degree of secondary radiation and is less penetrating and more caustic. Strong irradiation of bone will cause productive osteitis, which is usually followed by noticeable thickening of the shaft of the bone at the expense of the marrow cavity. The cancellous bone is greatly replaced by cellular marrow, and its fat is replaced by a brittle bonelike tissue. The periosteum becomes thickened and strips readily. In the observation of radiation osteitis of the femur no osteoblasts were found along the osteogenetic layer of the periosteum. There were decalcification and partial necrosis of some of the trabeculae in the spongy portion. Large vessels showed hyaline changes, and capillary vessels were imperfect, with an evident failure of formation of callus.

Present knowledge of the anemias and of generalized infections of bone demonstrates that bone must not be classified as an inert substance. It is probably one of the most highly specialized tissues in the body. Body tissues and cells which have a less extensive vascular supply and anastomosis have a lower therapeutic and pathologic factor of safety. When the blood supply is insufficient because of an impairment of the venous return, physiologic processes are impaired and tissues degenerate physiologically and structurally, producing the pathologic process of necrosis in all its stages. This is the picture of an overexposure to roentgen rays or to radium, of trauma and of some forms of chemical poisoning. Vascular anastomosis in bone is circumscribed by two conditions: first, absence of large intercommunicating vascular channels and, second, relative constriction of the channels by nonexpansive bone structure.

Radiation osteitis is produced by a combination of radiation and infection. Destruction of carcinoma by radium at the gingiva nearly always causes loss of the corresponding segment of bone. Dead bone favors growth of bacteria throughout the haversian system, including the canaliculi. The use of intense radiation in or about bone, especially when infection is liable to follow, should be avoided.

Diagnosis.—The first symptoms of dental disturbances following radiation therapy are: (1) hypersensitivity of the teeth to sweets, cold and heat; (2) a sensation of elongation of the teeth, which is due to inflammation of the peridental membrane and the alveolar socket; (3) decrease in the amount of saliva; (4) continuous dull pain similar to toothache but more severe.

Clinical examination at this time is more reliable than study of a roentgenogram. There may be some thickening of the bone and of the periosteum at this stage. Diagnosis is not difficult when there are swelling and ulceration of the soft tissues, trismus, draining sinuses and exposed bone. Roentgen examination at this time will show destruction of bone. A fistula may communicate with the oral cavity, draining saliva. The bone soon appears slate gray and is rough; spontaneous fracture is very common, and sequestrums may occur.

Prophylaxis Against Osteoradionecrosis.—The following recommendations are made: (*a*) All teeth, good or bad, should be removed on the side that is to be subjected to high voltage radiation externally and in some cases in which radium therapy is to be used near the jaws. (*b*) For roentgen radiation peroral lead portals should be used to constrict the direction of the beams and to prevent injury of bone. Normal tissue and bone should be protected by lead shields. (*c*) When radium is used interstitially, special lead shields reenforced with dental compound should be worn at all times except while eating. (*d*) Strong mouth washes should not be used, such as those containing salts of heavy metals, astringents or iodine. A capable dentist should be obtained to supervise oral hygiene. All dental pulps that have been devitalized by radiation should be extirpated and the root canals filled. Teeth should not be extracted for several years (as mentioned before) following high voltage roentgen irradiation of the jaws.

Once the tissues have been burned by radiation, such measures as ligation of vessels and control of hemorrhage are almost impossible because of friability of tissues. Future surgical intervention is often difficult because the circulation is impaired. Therefore, treatment with high voltage roentgen rays should not be attempted except as a last resort. It is unwise to treat all cancers with one type of therapy, nevertheless, most of the cancers in this country are treated with some form of radiation. Since the discovery of radium by Curie, the layman and the physician alike have linked the treatment of cancer with some type of radiation. The majority of the members of the medical profession regard cancerous changes in the same light as laymen view leprosy—it is something to be avoided. With these facts in mind it is clear that little salesmanship is necessary in order to induce patients to accept the easier method of therapy and to reject the surgical operation as a more radical procedure. Present knowledge of the therapy of cancer demonstrates that no one method of treatment is universal and that the term "cancer specialist" is a misnomer so far as treatment is concerned; that is, no individual physician is capable of such diversified treatment unless he qualifies as a consultant

in diagnosis. The diagnosis and the treatment of cancer should not rest in the hands of one doctor, for they require the cooperation of the internist, the surgeon, the pathologist, the dermatologist and the radiologist. Many hospitals have solved this problem by the establishment of "malignancy boards" not dominated by a particular specialty. These boards determine the diagnosis and outline the treatment of cancer. Special training can be obtained in cancer work in recognized hospitals in this country, but unfortunately many of these institutions are under the influence of physicians who advocate nonsurgical methods of cancer therapy.

Summary.—Osteoradionecrosis is a serious and often fatal complication caused by roentgen or radium therapy plus infection. Since the introduction of high voltage roentgen rays as a therapeutic agent it is more prevalent than one would imagine.

The bones most frequently attacked are in the following order: The mandible (which has the poorest circulation), the maxilla and the bones of the skull.

Radiation directly injures the periosteum, the bone cells and the marrow and produces sclerosis of the blood vessels and the lymphatics. These structures are found in an intraosseous vascular system which is contained in a nonexpansive bony structure causing death of the involved bone.

In the early stages this condition cannot be diagnosed by roentgenogram, and this is also true of cancer of bone. The early symptoms are persistent pain in the injured bone, hypersensitivity of the teeth to sweets, cold and heat and sensations of elongation of the teeth. In advanced cases the soft tissues are broken down and an external fistula may result; there are also bone sequestrums, and frequently pathologic fractures occur, for the bone seldom regenerates.

The mortality is high. Patients seldom die of cancer per se but usually of hemorrhage or of bronchopneumonia.

Treatment is primarily prophylactic. All teeth, good or bad, on the side of the jaw to receive high voltage roentgen radiation should be extracted. This rule should also be followed in the use of radium near the bone.

Resection of the jaws following radionecrosis carries a high mortality. Therefore, the treatment should be more conservative.

The minimum lethal dose for intraoral cancer is from 7 to 10 skin erythema doses in from ten to twenty days. However, with external radiation it is difficult to give more than 2 erythema doses without destruction of tissue and perhaps fatal termination.

For basal cell carcinoma of the skin the authors advise the use of roentgen radiation; for a neoplasm of the lip, a wide V-shaped incision with the cold scalpel. For carcinoma of the tongue, radium implantation and the electric knife are advocated. Radium is the best treatment for carcinoma of the tonsil and pharynx. For carcinoma of the floor of the mouth the electric knife is used. If the tumor is near the mandible, a resection is also done. If there is carcinoma of the antrum of Highmore, a cherry red ball-shaped cautery is used, or exenteration of the maxilla is performed.

With lesions of tissues in the head and neck high voltage roentgen rays should be used only as a last resort, as the burned tissues become friable so that ligation of vessels is impossible and future surgical treatment is hampered.

The diagnosis and treatment of cancer should be under the direction of a cancer board not dominated by a single specialty. The consciousness of the great danger of osteoradionecrosis following heavy irradiation of the jaws should be disseminated to the profession with evangelical fervor.

DISCUSSION

DR. LOUIS H. CLERF: Major Stewart has brought to attention a very important subject in the field of cancer therapy. I quite agree that physicians in general do not fully appreciate the frequency of untoward reactions following irradiation of bone. I refer not only to the immediate but to the remote effects. I have made two contributions on the untoward effects of irradiation of the larynx and trachea. Several years ago 2 patients, both men, came under my care. They had been receiving radiation therapy for exophthalmic goiter. In one of the patients five years after, and in the other seven years after irradiation of the region of the goiter there developed obstructive laryngeal dyspnea. Mirror examination revealed edema of the larynx with stenosis requiring tracheotomy. Within a few days after tracheotomy had been performed, wounds broke down and there was much loss of soft tissues as well as loss of the thyroid and cricoid cartilages, of a portion of the hyoid bone and of several tracheal rings. One of the patients died in about two weeks; the other survived, but there remained a large unhealed area over the front of the neck which was roughly 5 by 7 mm. in size. Practically all of the larynx had been lost, and the tracheal stoma was very large.

In my associations with Dr. B. P. Widmann of the radiologic clinic of the Philadelphia General Hospital I have seen several cases of osteoradionecrosis of the lower jaw. These

occurred before such a thing as prophylaxis was generally known, and the teeth had not been extracted preliminary to irradiation of the jaw. One of these cases proved fatal. In another bony splinters were shed for over two years and many fistulas developed over the mandible. The patient ultimately lost a great part of the mandible, and Dr. Merle Miller has spent a considerable period in trying to rebuild his lower jaw.

I am heartily in favor of irradiation of neoplasms, but if there is a question of surgical removal or irradiation of the growth, it is important to bear in mind that once irradiation of the growth has been carried out it is very probable that surgical skill cannot be employed if the growth is situated in the air or upper food passages. I have had the misfortune of doing laryngectomy on 3 patients who previously received intensive radiation treatment for carcinoma, which recurred. Following laryngectomy, the entire wound broke down in every instance. One patient, operated on during 1937, still had a large pharyngeal stoma when, four years later, death resulted from a cardiac accident. The remaining 2 patients still have enormous unhealed areas, and it undoubtedly will require many months if not years of plastic surgical procedures before these stomas can be closed. It is important, therefore, if one contemplates irradiation of a neoplasm to recall that if this is unsuccessful, surgical treatment cannot be employed if the field of operation communicates with the mouth or the throat.

I greatly appreciated Major Stewart's discussion, and I am sure all have benefited by his excellent presentation.

DR. JOHN V. BLADY (by invitation): Major Stewart's presentation is most timely, and he is to be congratulated on his reminder that in the treatment of cancer one is dealing not only with a dreaded disease but with a complication of the treatment of this disease, namely, radionecrosis. Because radionecrosis is associated with the use of an external or an interstitial source of radiation, with or without surgical intervention, it is often not recognized or is misdiagnosed by the physician who is unfamiliar with its appearance. Frequently radionecrosis is mistaken for a sloughing recurrent neoplasm and the involved region is given more radiation. Naturally such additional irradiation of the tissues could be disastrous. On the other hand, when the condition is promptly recognized, proper early treatment results in hastening of the reparative process.

Major Stewart primarily discussed radionecrosis of bone. One must remember that radionecrosis may involve also the soft tissues. Radiation necrosis may occur during treatment or soon after healing of the radiation reaction, or it may occur years later. It should always be recognized that this condition may occur as a sequela of untreated fungating cancer.

In the series of cases of cancer of the lip reported from Memorial Hospital by Martin, MacComb and Blady to which Major Stewart referred, radionecrosis developed at the site of the primary lesion, following use of radon seeds, in 7 per cent of the cases. Of the patients treated by roentgen rays for extensive growths on the lips or for metastases under the edge of the mandible, radiation osteonecrosis developed in 2 per cent.

Recently I had the opportunity of seeing a patient who was treated with radium for a pituitary tumor twenty-five years ago. To date the tumor has not recurred. About three or four months ago she noted some impairment in hearing and recently experienced pain in the nasopharyngeal region. On examination an ulcer was noted on the left side of the nasopharyngeal vault. The possibility of a recurrent or of a primary neoplasm was raised. The clinical appearance, however, was typical of latent sloughing radionecrosis of soft tissues and bone. A biopsy was made and the findings were reported negative for neoplasia but consistent with inflammatory sloughing.

The mechanism of radionecrosis has been explained well by Dr. Stewart. Infection, especially a symbiotic existence of aerobic and anaerobic organisms, nearly always is productive of necrosis. In latent necrosis the infection frequently has been preceded by trauma. This fact needs emphasis because proper precautions may obviate the occurrence of this complication.

The treatment of osteoradionecrosis should be directed along two channels: (1) the strict observance of prophylactic measures employed as a preventative and (2) the treatment of the complication.

Dr. Stewart has thoroughly discussed the prophylactic measures that should be employed. The one point I wish to emphasize and reemphasize is *the necessity of removing all teeth in the area which is to receive treatment.* This point cannot be overemphasized!

In the treatment of sloughing radionecrosis the following measures should be employed: (1) oral hygiene; (2) irrigation with an alkaline solution as frequently as is necessary; (3) gentle removal of the slough from the necrotic area; (4) application of zinc peroxide to the sloughing area.

Zinc peroxide after proper activation by heat for four hours at 140 C. has the property of slowly liberating nascent oxygen over a period of twenty-four hours or more. It has no

caustic effect on tissue and is almost tasteless. In addition to being able to kill anaerobic bacteria, it is a highly efficient deodorant. Sloughing radionecrosis of oral wounds is characterized by a typical offensive odor. This disappears within twenty-four hours.

DR. GABRIEL TUCKER: Major Stewart has presented most forcefully an important and timely subject. In medical papers one is prone to present successes and neglect fatal complications, particularly in dealing with cancer, which is always fatal if left untreated. However, when the effort to cure produces a complication that will prove fatal the result is most discouraging to the physician and to the patient. One knows that radiation will kill cancer cells. It will also kill normal tissue. It is the hope of the radiologist to destroy the tumor and preserve the normal tissue. Osteoradionecrosis is much less frequent with the newer methods of application of radiation, both roentgen rays and radium, than formerly.

My own particular field in the treatment of cancer is limited to the larynx and its adjacent structures. In the larynx the tissue most likely to undergo radionecrosis is the cartilage. In a few cases of cancer of the larynx the cancer has been cured by the use of radiation and the cartilages of the larynx destroyed by the same therapy. In these cases it has been possible to save the patient's life and in some measure to salvage portions of the laryngeal structure.

I wish to show 1 patient—a man who presented himself ten years ago with extensive intrinsic cancer of the larynx. His general condition was such that after a careful preoperative check-up it was thought inadvisable to attempt laryngectomy. The type of carcinoma and the location and extent of the lesion indicated that this would have been the procedure of choice. Because of dyspnea, due to obstruction in the larynx, tracheotomy was done. The larynx was then opened. Radium capsules were placed within the larynx and the patient given roentgen radiation externally. A severe reaction was observed following this procedure. The patient went through a stormy period of convalescence, during which there occurred some bleeding and finally the coughing up and expulsion of all the cartilaginous structures of the larynx, including the thyroid, cricoid and arytenoid cartilages. The normal mucosa within the larynx, however, was preserved, and an airway is still present through the larynx, although the patient is required to wear a tracheotomy tube because of lack of support after the loss of cartilage.

This patient reported for observation just a few days ago. A photograph was made showing his present condition. He is in excellent general health and is able to talk by placing his finger over the tracheotomy tube, which he constantly wears, and pursues his usual occupation without discomfort. Actually the patient presented had laryngectomy by radiation therapy.

In the treatment of extrinsic cancer, however, there is a definite place for radiation. It can be used in successful therapeutic dosage with little danger of necrosis of either cartilage or bone. An experience of twenty-five years in the treatment of cancer of the larynx has convinced me that the advances made in irradiation of neoplasms in recent years justify the use of radiation in cases of extrinsic cancer of the larynx. In cases of intrinsic cancer, however, the surgical is the best method of cure when the disease is localized. In some instances a combination of surgical and radiation treatment will accomplish the best results. In the prevention of radionecrosis one of the most important facts to be kept in mind is that the patient's toleration to radiation varies. With some patients very large doses may be used without necrosis, while in another patient very small doses may produce extensive necrosis of cartilage.

I want to thank Dr. Stewart for bringing forward a most important paper.

MAJOR MARSHALL B. STEWART: First, I want to thank the societies for allowing me to come here to present this paper. There are many more subjects that I could have brought in to discuss.

Just as Dr. Blady has said, if physicians can be impressed with the importance of extracting the teeth before irradiation of the jaws it would be a great help in obtaining better results. I have gone over all the literature and find that only 7 or 8 cases have been reported in the United States.

The figures that Dr. Blady presented correspond with my figures. Dr. Blady mentioned that there is radionecrosis of soft tissue also. Dr. Ewing in his paper reports good results in the treatment of radionecrosis in some cases in which the teeth were not removed.

If a tooth is broken, attempts should be made to fill it. If a piece of tooth breaks off before the canal is exposed, the tooth has to be treated to prevent infection in the canal. However, such teeth will sometimes exfoliate of themselves.

In regard to zinc peroxide, I use it in plastic surgery. I have never used it in cases in which there has been involvement of the mouth.

The After-Image Test. Dr. Frank A. Bridgett.

Bárány stated "Rotary dizziness was known even to the ancient Greeks and is very well described by them." I was able to find a great number of dissertations, more than one hundred, of the sixteenth, seventeenth and eighteenth centuries on dizziness. It is peculiar that they all are about the same. In the Middle Ages observation was almost completely dropped. Whoever wrote a book studied the writings of his predecessors and in the end copied with trifling changes what had been said before him. For instance, in the matter of rotary dizziness now interesting me and my colleagues, various authors speculated as to whether during the dizziness unconscious eye movements appear or not, but it occurred to no one to turn around a few times himself, to touch his eyes and to ascertain if he could feel such eye movements, or to ask a good friend to turn around and then observe him. The often ingenious reflections were made only at the writing table. The first to institute observations on this phenomenon was Purkinje, in the year 1825.

Being interested in the reactions produced by the caloric test of Bárány, I was making a study of the subject from the standpoint of the currents. I reviewed his lecture giving a short history of his discoveries. I had tried this experiment of his before while standing up, and a short while later the thought occurred to me while I was sitting at my desk to fix my gaze on an object, close my eyes, place my fingers on the closed lids and turn my head

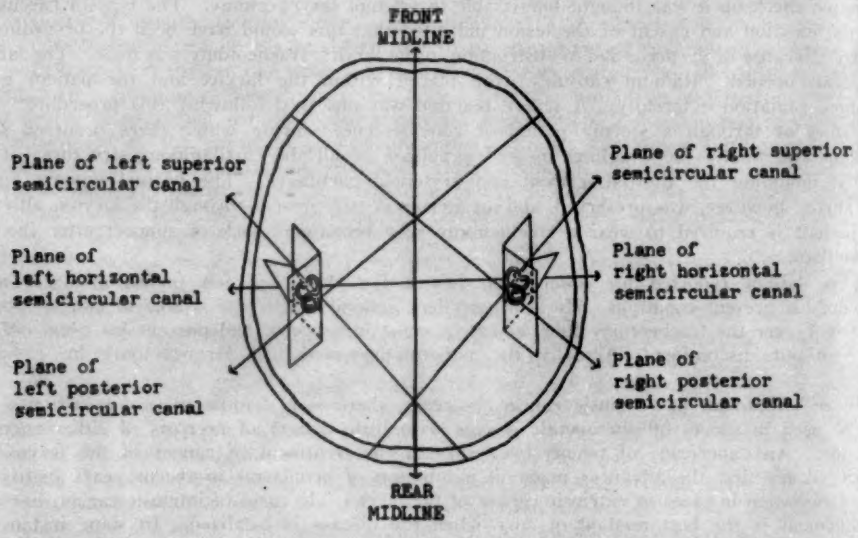

Diagram aid for the after-image test.

Tilt the head in the direction of each of the side-arrowed lines, which indicate the plane of the vertical canals in which the cristae are stimulated. Rotate the head in the direction of each of the side-arrowed lines, which indicate the plane of the horizontal canals in which the cristae are stimulated. Only the crista of one canal at a time can be stimulated by tilting or rotating the head in the direction of the side arrows.

Tilting the head forward and downward in the midline stimulates the cristae of the right and left superior canals at the same time.

Tilting the head backward and downward in the midline stimulates the cristae of the right and left posterior canals at the same time.

quickly to the right while trying to keep my eyes fixed in the position in which I saw the object, in order to prevent the eye movements, as I thought, not recalling the fact that my head made less than a quarter turn. I tried this a couple of times, the whole procedure being done quickly.

Finally I looked intently at the object a little longer than before, turned my head quickly and perceived that the after-image of the object looked at appeared and moved from side to side. The object fixated was brightly illuminated by the sun's rays. Immediately I recognized the significance of the movements of the after-image. I knew that the movements were due to the movements of the eyes caused by the sensory stimulation of one of the cristae of the horizontal canals, followed by the cortical or cerebral response. Shortly after, in a dark room

I looked at an electric light on an adjustable wall bracket, then turned the light off. I closed my eyes and rotated and tilted my head in the planes of the various canals and observed the movements and directions of the image.

In order to interpret the reactions seen in the movements and directions of the image, I drew an outline of a skull in which I had opened up the semicircular canals on both sides and took accurate measurements of the same and made a diagram as an aid. From my experiments I discovered the following facts:

The normal physiologic movement of the head when rotated or tilted in the direction of any of the side-arrowed lines, passing through the planes of the canals, produces the following results:

1. Only one crista of the vertical canals is stimulated at a time when the head is tilted in the direction of a side-arrowed line passing through the plane of a specific canal, followed by the motor responses of the eye muscles, thereby producing by the combined reactions specific movement and direction of the image, which are constant for the said canal.

2. The sensory stimulation of the right crista takes place when the head is rotated to the right in the direction of the right-arrowed line passing through the plane of the right horizontal canal, followed by the motor responses of the eye muscles.

3. The sensory stimulation of the left crista takes place when the head is rotated to the left in the direction of the left-arrowed line passing through the plane of the left horizontal canal, followed by the motor responses of the eye muscles. As to the initial speed factor in the case of the horizontal canals, the sensory and motor excursions are wide and assume more normal excursions later in an effort of the eyes to come to a balance or to establish equilibrium of the external and internal recti muscles.

4. The normal movement of the head in the direction of the front midline arrow, not passing through the plane of any canal, produces a sensory stimulation of the cristae of the right and left superior canals at one and the same time, followed by the voluntary motor responses of the eye muscles. The sensory stimulus set up at the same time in the right and the left crista is reflected in the counteracting reaction of the musculomotor responses of the eyes, with a compromise of the image movement upward. The sensory stimulus of either one or both cristae is not stopped but continues on.

5. The normal movement of the head in the direction of the rear midline arrow, not passing through the plane of any canal, produces a sensory stimulation of the cristae of the right and left posterior canals at one and the same time, followed by the voluntary motor responses of the eye muscles. The sensory stimulus set up at the same time in the right and the left crista is reflected in the counteracting reaction of the musculomotor responses of the eyes, with a compromise of the image movement upward. The sensory stimulus of either one or both cristae is not stopped but continues on.

DISCUSSION

Dr. George W. McKenzie: First, my compliments to Dr. Frank A. Bridgett for his ingenuity as manifested on more than one occasion.

Although I cannot agree with all that he claims in the paper which he has just presented, nevertheless it should be carefully read and reread by all those interested in the physiology and the pathology of the labyrinth.

It was a privilege to study the subject under those masters who brought it to light in the Physiologische Institut of Vienna and in the Politzer Klinik. To my credit or discredit I was not always in accord with the masters and tonight I find myself in much the same position.

I repeated the experiments as outlined to me privately by Dr. Bridgett and was unable to confirm his findings, which was as much of a disappointment to me as to him. I hope that he is right and that I am wrong. I loaned him one of my nurses and a granddaughter as material for further experimentation. As to how he managed with them he can better tell than I who was not present.

As to the duration of the rational nystagmus referred to by Dr. Bridgett, investigators have differed considerably. For instance: Bárány claimed that after ten turns the duration of the nystagmus varied from nought to one hundred seconds. I promptly contradicted Bárány's findings but only after a greater number of tests than he had made up to the time of his first publication, "Physiologie und Pathologie des Bogengang-Apparates beim Menschen," pointing out that his mistake was due to nothing else than faulty technic. Since then no case of such variable findings has been found by any one in any country. His findings in regard to after-turning nystagmus must therefore be disregarded, as well as all that he has said about *nach und nach* nystagmus, which no one has been able to confirm.

As for the rotary dizziness referred to by the worthy essayist, it varies with the experience of the researcher and the habits of the subject tested. The case of a whirling dervish Hash-Hash is recalled. It was found that his after-turning nystagmus was but ten seconds, compared with the normal twenty-four seconds; besides, he experienced no subjective symptoms of rotary dizziness. He was examined for an hour at a time on three different occasions. Although in a general way rotary dizziness is of some importance, it would better be replaced by its objective concomitant, after-turning nystagmus. However, in fairness to Dr. Bridgett one must take into account the dizziness to which he refers, though with some allowance for an important subjective variable.

That one can inhibit the rolling of the eyes by finger pressure through the lids during or immediately after a rapid movement of the head is questionable. Every movement of the head either with eyes open or closed causes the eyes to move reflexly in the opposite direction. This is the normal reflex, and it cannot voluntarily be stopped. Immediately following this slow reflex movement there is a rapid voluntary movement in the same direction as the head was moved but only during consciousness of the patient. It fails in the unconscious state. In the place of nystagmus there is conjugate deviation of the eyes directed away from that of the nystagmus as found in the conscious state. In other words, since the quick movement is a conscious one, its elimination during loss of consciousness leaves only the reflex remaining.

The two posterior canals are at right angles to each other. The inferior canal of one side and the posterior of the other lie in parallel planes. Hence the essayist made another mistake. When referring to the backward movement of the head, he stated that the normal movement of the head in the direction of the rear midline, not passing through the plane of any canal, produces a sensory stimulation of the cristae of the right and left posterior canals at one and the same time, followed by the voluntary responses of the eye muscles.

I believe that I have exceeded my time limit and will therefore quit. I hope Dr. Bridgett will accept my criticism as intended. May it stimulate him to further efforts in the same direction and with the better success which he well deserves.

Book Reviews

Allergy. Erich Urbach, M.D., with the collaboration of Philip M. Gottlieb, M.D. Pp. 1,073, illustrated. Price $12. New York: Grune & Stratton, Inc., 1943.

Experimental and clinical allergy are progressively converging toward a point at which there is some unanimity of opinion between investigator and clinician. Much skepticism is encountered in the medical profession concerning not only the diagnostic technic of the allergist but more especially his ability to produce hyposensitization in the allergic person. In this treatise Urbach presents many of the controversial subjects in allergy, giving his own ideas for and against each opinion. Recent advances in the field of allergy are included in the book in a most comprehensive manner.

The contents are divided into three sections:

Part 1 includes the basic fundamentals and principles of allergy with particular reference to the methods of diagnosis and treatment. The classification of the different phenomena of hypersensitization and hyposensitization is unique in its nomenclature. A detailed discussion of such unfamiliar terms as "pathergy," "hetero-allergy," "parallergy" and "metallurgy" is exceedingly interesting though slightly confusing.

Part 2 covers entirely the majority of the usual etiologic agents and excitants in allergy. Reports of new allergens or atopens are appearing daily in the literature, and this text is complete to the present date.

Part 3 is directed to a discussion of the symptoms, diagnosis and treatment of allergic disease. The chapter on allergic diseases of the upper respiratory tract is of special interest to the otolaryngologist. The pollen calendars for each season and section of the country are quite clear and concise. Also, in this section, there is a most complete and illuminating survey of allergic cutaneous diseases with accompanying photographs, which are unusually well done.

The following considerations recommend this book to the general practitioner and specialist: the vast amount of literature covered and the extensive reference list, the section on atopic dermatoses with many clear illustrations and, lastly, the completeness of the text and the detailed arrangement of the practical methods of diagnosis and treatment.

CORRECTION

In the article by Dr. Francis L. Lederer and Dr. Robert Dinolt entitled "Influence of Avulsion of the Trigeminal Nerve on the Human Nose," in the June issue (ARCH. OTOLARYNG. **37**:768, 1943), the term "nicotinic acid" in the fourth line from the top of page 774 should read "nicotine."

Directory of Otolaryngologic Societies *

NATIONAL

American Medical Association, Scientific Assembly, Section on Laryngology, Otology and Rhinology

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Secretary: Dr. Louis H. Clerf, 1530 Locust St., Philadelphia.

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President: Dr. James A. Babbitt, 1912 Spruce St., Philadelphia.
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Place: Chicago. Time: Oct. 10-13, 1943.

American Broncho-Esophagological Association

President: Dr. Robert L. Moorhead, 125 Ramsen St., Brooklyn.
Secretary: Dr. Paul Holinger, 700 N. Michigan Ave., Chicago.

American Laryngological Association

President: Dr. Charles J. Imperatori, 108 E. 38th St., New York.
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American Laryngological, Rhinological and Otological Society, Inc.

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American Otological Society

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* Secretaries of societies are requested to furnish the information necessary to keep this list up to date.